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TRACHEOTOMY IN LARYNGEAL DIPHTHERIA



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TRACHEOTOMY

IN

LARYNGEAL DIPHTHERIA.

" Un remède expérimenté vaut mieux qu'un désespoir assuré."

HABICOT.

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TRACHEOTOMY

IN

LARYNGEAL DIPHTHERIA

(*MEMBRANOUS CROUP*),

WITH

ESPECIAL REFERENCE TO AFTER-TREATMENT.

TO WHICH ARE ADDED

A FEW GENERAL REMARKS ON DIPHTHERIA, AND ITS EARLIER TREATMENT.

BY

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TO

CHARLES WEST, M.D., F.R.C.P.,

CORRESPONDING MEMBER OF THE ACADÉMIE DE MÉDECINE OF PARIS;
FOUNDER OF THE FIRST CHILDREN'S HOSPITAL IN ENGLAND,
AND FOR TWENTY-THREE YEARS ITS SENIOR PHYSICIAN;

UNDER WHOSE SUPERVISION MY FIRST

TRACHEOTOMY

WAS PERFORMED, AND THANKS TO WHOSE CARE
IT PROVED SUCCESSFUL;

IN RECOGNITION OF HIS DISTINGUISHED SERVICES IN THE
CAUSE OF SICK CHILDREN,

AND

IN ACKNOWLEDGMENT OF MUCH PERSONAL KINDNESS,

I RESPECTFULLY AND GRATEFULLY

Dedicate

THIS VOLUME.

PREFACE.

THE primary objects of this little book are two :—1. To advocate the utility and importance of local treatment in cases of laryngeal diphtheria (membranous croup); and 2. To give, for the use of house surgeons and practitioners, short but detailed instructions as to how this may be practically accomplished.

I am emboldened to publish it by the favourable reception which a paper of mine on the same subject received from the Fellows of the Royal Medical and Chirurgical Society in the early part of last Session, and which will be found in the last volume of the Transactions published by the Society. This book is to be regarded as an enlarged edition of that paper, and as containing details, which, though useful in practice, were not exactly adapted for reading before a learned Society. I would take this opportunity of thanking the Council for their kind permission to me to use for this book some of the woodcuts which illustrate the paper just referred to.

The recent discussion on "Tracheotomy in Croup" at Cork, at the Meeting of the British Medical Association, still further impressed me with the belief that my book will fill an acknowledged want in our medical literature, and that it will be acceptable to those for whom it is written.

It is perhaps not a little remarkable that none of our

English text-books enter into the subject of the after-treatment which tracheotomy cases require; although all make mention of the operation, and give most accurately the indications for its performance. I gladly acknowledge my indebtedness to these standard works.

There are few subjects in medicine on which we possess a larger literature than on Diphtheria and its Treatment. I have naturally availed myself of all that has come within my reach. And while anxious most fully to do justice to previous work and previous workers in this subject, I nevertheless find it exceedingly difficult to rightly adjudge to its proper author the various rules of treatment, modifications, and improvements which have from time to time been adopted. This must be my excuse for any seeming neglect in this direction.

Although I am not aware that any similar plan of treatment has been elsewhere described or advocated as a matter of routine, I have doubtless, in developing the plan, been influenced by much that I have read. On this account, therefore, I would, for myself, disclaim all idea of priority or originality; for the mode in which the local treatment is carried out I consider as a mere detail, while the first use of this or that instrument I regard as too insignificant a ground on which to base a claim for originality in this special subject. I shall, elsewhere, give a list of those authors, with whose works I am best acquainted, and I would now collectively thank them for much that I cannot individually acknowledge.

The plan of treatment, herein advocated, has been adopted from a growing conviction that Diphtheria, *in the first instance*, is a purely local disease, and as such

largely requires at all subsequent stages local measures for its eradication. So strongly do I believe in the infectiousness, as well as the mechanical danger, of the local manifestations of this disease, that—for my own better guidance, and with a view to keep well in my mind's eye *the great indications for treatment*—I have formulated the following somewhat absolute dictum :—

THE PRESENCE OF MEMBRANE IN THE TRACHEA IN A FATAL CASE OF MEMBRANOUS LARYNGITIS, AFTER TRACHEOTOMY, MUST BE REGARDED AS EVIDENCE OF THE WANT OF DUE CARE ON THE PART OF THE SURGEON IN CHARGE, JUST AS MUCH AS WOULD THE PRESENCE OF A PIECE OF GUT IN THE INGUINAL CANAL AFTER HERNIOTOMY, OR A CALCULUS IN THE BLADDER AFTER THE OPERATION OF LITHOTOMY.

I have great pleasure in acknowledging much valuable help, and many able suggestions, from my friend Dr. Sidney Coupland, of the Middlesex Hospital.

8, OLD CAVENDISH STREET, W.,
March 1880.

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TRACHEOTOMY

IN

LARYNGEAL DIPHTHERIA.

CHAPTER I.

INTRODUCTION.

I. **Historical Survey.**—Under the term Bronchotomy the operation of opening the windpipe was known to, and described by, the earliest writers. Kurt Sprengel,* in his admirable history of surgical operations, gives a full bibliographical account of it. It is from this author chiefly, that I have compiled the following brief *résumé.* Asclepiades, of Bithynia, who flourished during the time of Cicero, appears to have been the first to perform this operation. It seems to have been successful, for Sprengel, quoting Cælius Aurelianus, says, "in this manner he saved a great many persons who were in danger of perishing from suffocation."

The operation met with considerable opposition: among others, from Aretæus, who feared that the rings of the trachea would never unite again. After an interval of about two hundred years, Antyllus revived the operation. It, however, again fell into abeyance, and was not further practised for upwards of fourteen hundred years, when Benivieni, of Florence, operated for what seems to have been dyspnœa, produced by a retropharyngeal abscess.

* 'Geschichte der Chirurgie,' Halle, 1805.

Fabricius (ab Aquapendente) gives the first detailed account of the method of operating. Jules Casserius, a pupil of Fabricius, gives a still more detailed account, with drawings of the instruments necessary and the incision in the trachea.

Laurence Heister (who flourished in the early part of the eighteenth century) was an active partisan of the operation, and described its mode of performance and its indications with considerable minuteness.

The operation from this time onwards seems to have become naturalized in surgery ; it was advocated and performed by all the principal surgeons from this date down to our own times.

Surgeons have always considered the operation a difficult one, and it was this circumstance which induced Dekkers, a Dutch surgeon (1694), to propose the use of a tracheotome instead of the scalpel which had ordinarily been used. His tracheotome was not unlike our well-known trocar and canula ; it was plunged into the trachea just as we now plunge it into the abdomen in case of ascites. Sundry other tracheotomes—some very ingenious—have been proposed since, but none of them has ever been very widely used.

It seems probable that the earliest surgeons did not use any canula after opening the trachea ; at all events, there is no account of them ; and I am unable to state by whom they were introduced. Fabricius (ab Aquapendente) used a short, straight tube. Casserius preferred them slightly curved. Nicholas Habicot, somewhat later, returned to the straight tube. Perhaps the most important change as regards the tubes was the introduction of the double tube in 1730. This is due to Dr. George Martin, and is recorded in the thirty-sixth

volume of the 'Philosophical Transactions,' p. 448. The author is giving "an account of the operation of Bronchotome." The case seems to have been one of laryngeal diphtheria: the operation was completely successful, the canula being removed on the fourth day. He says, "I cannot but think it an ingenious proposal of one of our ministers here to make the pipe double, or one within another; that the innermost might safely and easily be taken out and cleaned when necessary without any molestation to the patient. . . ."

It has been proposed by one author to substitute for the knife, caustics; by another, the actual cautery; by another, the galvano-cautery; by another, a heated scalpel. In each case, it was hoped thus to avoid hæmorrhage or to lessen its amount.

The diseases or accidents for which and in which tracheotomy has been performed are many and various. Foreign bodies in the trachea, and angina, were the earliest indications. Subsequently it was proposed in cases of drowning, with the double object of drawing water out and forcing air into the lungs. Dr. Marshall Hall proposed it in cases of spasm of the glottis during an epileptic seizure; it has been practised also during tetanic spasm. Further, intra-laryngeal growths may necessitate the operation; as also tumours in the neighbourhood of the trachea, which, either by displacing it, or by pressing upon it, or by paralysing the nerves which control the opening of the glottis, interfere with the free and easy entrance of air into the lungs.

Of all the many writers on the subject of tracheotomy, there is one more especially whose name stands pre-eminent. I refer to Trousseau. It was through his labours and genius that the operation became popularized,

and it is to him that we are indebted for the most important improvements that have been made, both in the operation itself and in the mode of its after-treatment.

II. **General Remarks on Tracheotomy.**—Although this book is intended to treat chiefly of tracheotomy in membranous laryngitis, and of the "after-treatment" which the disease requires, I have thought it well to add the following general remarks before proceeding to my special subject. And first I would caution against the idea of a "hard and fast line" of treatment. It must always be borne in mind that the "after-treatment" will depend on the primary lesion which has necessitated the operation, rather than on any peculiar condition which the operation itself introduces.

For the after-treatment of a simple tracheotomy, undertaken, for instance, for the removal of a foreign body recently lodged in the windpipe, is of the simplest kind. Complications are very uncommon, and a large majority of the cases quickly recovers.

On the other hand, when the operation is undertaken to relieve a symptom or a consequence of disease, we still have to grapple with that disease; the which, if unrelieved, may be fatal. The operation has usually but little to do with the fatal issue. Thus our after-treatment will vary immensely, and must always be carried out in reference to the primary disease.

If the operation has been called for in order to remove a foreign body, the wound may be allowed to close immediately after the foreign body is extracted. If the operation is indicated on account of paralytic closure of the glottis, we must cure the paralysis before the tube can be finally removed, or our patient will not be

benefited. If pathological new growths are present, they must, if possible, be removed. If a temporary spasm has threatened life, the operation will quickly relieve it, and as *spasm* cannot persist long, neither need the trachea remain long open.

As regards the operation itself, it may be enunciated broadly, and whatever be the nature of the circumstances, that tracheotomy is indicated in cases of increasing and persistent dyspnœa, which are due to disease or mechanical obstruction in the larynx or adjoining part of the trachea.

The problems for the surgeon to solve are :—1st, what are the symptoms by which such laryngeal obstruction may be diagnosed ; and 2nd, at what stage should an operation be undertaken. The most reliable symptom —and one which is common to all forms of obstruction —is recession of the soft parts of the anterior chest-wall during inspiration. In rickety children, however, one must never forget, in estimating this sign, that the chest is frequently malformed ; and therefore some allowance must be made for this possible natural deformity.

It is in children, nevertheless, that this symptom is most manifest, although it is present in adult subjects. Thus whenever we see that the epigastrium, the supra-clavicular spaces, the supra-sternal notch, and the intercostal spaces are more or less forcibly retracted during inspiration, we may feel quite sure that there is serious mechanical obstruction to the entrance of air into the chest. And if, together with this recession, there is more or less complete suppression of voice, then not only is the symptom the more serious, it is, further, an indication that the obstruction is situated in the larynx.

THE STAGE FOR OPERATING.—It is not easy to

specify the exact moment that an operation ought to be done. If the dyspnœa is very intense—other remedies having failed—there is then no choice but to operate. The question, however, is, should we let our patients get to this stage before we operate? By common consent, the operation itself is not dangerous, and it hardly, if at all, complicates the primary disease, which calls for it. On the other hand, the dangerous nature of the lung collapse which quickly supervenes in cases of this kind is well known, and it may be well therefore to operate before delay renders success all but impossible.

It will be wise in all cases to adopt certain precautions. The patient will, of course, be in bed, and, when the cause is doubtful, isolated from the rest of the household; and the atmosphere of his room should be kept uniformly warm and moist. He should never be left alone. As regards diet, solid or semi-solid food may be given; indeed, this is sometimes more easily swallowed than liquids.

CHAPTER II.

MEMBRANOUS LARYNGITIS.

It is not my intention to discuss the still disputed question of the identity or otherwise of "croup" and "diphtheria." Suffice it to say, I agree with those who consider that these diseases are etiologically identical, and that therefore the terms "membranous croup," "diphtheritic croup," and "laryngeal diphtheria" are, to me, synonymous.

For my own part, I hold it wise for a surgeon to have definite notions on this subject; for unless he have, he will be apt to neglect those precautionary measures which are as prudent in sporadic cases as they are essential during the more general outbreaks of the disease.

The whole subject was discussed at the Royal Medicaland Chirurgical Society during the early part of last year, on the presentation of the Report of a Select Committee, specially appointed to inquire into the "Relations between Membranous Croup and Diphtheria." I cannot do better than refer those who may wish for further information to this very excellent Report, and to the debates to which it gave rise. I only enter on the subject at all, because I think that a glance at the symptoms of the disease will render the *rationale* of tracheotomy the more obvious; while a short summary of its pathology will *explain the purpose and bearing of the after-treatment which is here advocated.*

Pathology.—This peculiar form of inflammation is generally considered to be due to the influence of some

specific contagion. It is characterized by the presence of a membranous exudation on a more or less inflamed mucous membrane (or abraded skin). It is the direct result of the infectious virus, and at first is a purely local lesion. "The virus precedes and underlies the anatomical change." The disease spreads by the contagion of its own secretion, and it is in consequence of the absorption of this same morbid product that the system at large gradually becomes invaded. Excepting this result of the virus, very little is known about it; it spreads sometimes by direct contagion, and sometimes it prevails as an epidemic.

As to the original source of this *materies morbi* nothing is at present known. By some it is thought that, under favourable conditions of soil and atmosphere, it may originate *de novo;* but such a view is a purely theoretical one. Its apparent sources are foul air and foul water—"though whether as mere carriers of contagion cannot be determined"—and direct contagion from a diphtheritic focus. It occurs at seasons when diseases, which are called zymotic, prevail, such as measles, scarlet fever, and typhoid fever; and it is not infrequently associated with one or other of them in the same individual.

Although we have not as yet been able to isolate a peculiar organism which gives rise to the disease, and demonstrate it under the microscope, yet the evidence in favour of such an origin, it seems to me, is daily becoming more certain. It is true that Dr. Oertel, of Munich, long since described certain specific vegetable organisms as being present in diphtheria, and which he regards as the very essence of the disease. English pathologists, however, have not yet been able to convince

themselves of the truth of this view as regards cause and effect, because in many cases of well-marked diphtheria the organisms in question have not been found.

The false membrane varies much in character and in amount. Thus, mainly owing to the greater amount of the submucous tissue, it is much more adherent in the pharynx than in the larynx; whilst in the trachea and bronchi it is readily separable, and indeed it is often quite detached. This fact is very important in its relation to after-treatment. The membrane is "sometimes as soft as cream, sometimes resembling wash-leather" (Jenner). Microscopically it consists of altered epithelial cells, granular corpuscles, with more or less of fibrillar tissue. Occasionally vegetable growths are found. The exact nature of these products varies according to the part examined.

The condition of the subjacent mucous membrane differs greatly. Sometimes, after removal of the false membrane, there is no appreciable breach of surface; at other times, there is a very considerable breach of surface; and between these two extremes, almost any gradation may be met with. The mucous and submucous tissues present various degrees of inflammation; they are infiltrated with leucocytes, and their vessels are distended with blood. Sometimes the mucous membrane, without appearing to be abraded, is so œdematous, infiltrated, and swollen as to necessitate tracheotomy even when there is no false membrane present upon it.

Symptoms: Mode of onset.—Briefly stated, it may be said that membranous laryngitis begins in one of two ways. It may attack the larynx primarily; or, beginning elsewhere, may spread to the larynx secondarily. In the former case, the chief symptoms are those of

suffocation outweighing and hiding all others. In the latter, the laryngeal symptoms are preceded by those of depression and blood-poisoning. It is worth while to consider these points more in detail.

1. DISEASE PRIMARILY AFFECTING THE LARYNX (*Syn. Croup*).—I cannot do better than quote from Dr. West's classical work. "Croup generally comes on gradually, attended in *its first stage* by but few symptoms that could distinguish it from ordinary catarrh. Slight fever, drowsiness, suffusion of the eyes, and defluxion from the nares, attend it. The respiration is not perceptibly disturbed, and the cough, though frequent, presents no peculiar character. There is, besides, occasional complaint of slight sore throat, or of uneasy sensation about the larynx, but so slight as scarcely to attract attention, and not sufficient to cause any alarm.

"The duration of this stage is very variable: nor is there any regularity in the mode of its transition into the *second stage*. In the majority of cases, indeed, the transition takes place gradually; but thirty-six hours seldom pass without the supervention of some symptom, which, to the well-schooled observer, would betray the nature of the coming danger. Most symptoms may continue unchanged, perhaps scarcely aggravated; but a slight modification takes place in the character of the cough, which now becomes attended with a peculiar ringing sound, difficult to describe, but when once heard not easily forgotten. This peculiarity in the cough very often precedes any change in the respiration, and may sometimes be so slight as scarcely to attract the parent's notice at the time, and to be remembered only when the full development of the disease leads to inquiries as to how the attack came on.

"Soon after this modification of the cough has become perceptible, or even simultaneously with it, the respiration undergoes a change no less remarkable. The act of inspiration becomes prolonged, and attended with a stridor as difficult to describe, but as characteristic of the disease, as the tone of the cough. It often happens that these two pathognomonic symptoms first come on, or at least first excite attention, in the night, and that a child who at bedtime was supposed to ail nothing, or at most to have a slight cold, awakes suddenly with ringing cough and stridulous breathing, frequently in a state of alarm with marked dyspnœa. Through the whole course of the disease, indeed, an obvious tendency exists to nocturnal exacerbations, and to remissions as the morning approaches. . . .

"Soon, however, the dyspnœa returns with increased intensity; the whole chest heaves with the inspiratory effort, which is more prolonged and attended with greater stridor. *The cough does not increase in severity in proportion as the disease advances.* . . . From the first appearance of the more marked symptoms *the voice is hoarse, cracked, and whispering, or in young children is totally suppressed.*

"As the disease advances, the intermissions grow less distinct, and *the child is constantly engaged with the effort to respire.* . . ."

I shall not quote the symptoms of the last stage of this disease; for I hope that surgical help will be afforded, long before matters come to this pass.

2. DISEASE AFFECTING THE LARYNX SECONDARILY (*Syn. Laryngeal Diphtheria, Diphtheritic Croup*).—This form of the disease is preceded and accompanied by diphtheria of neighbouring parts. "Sore throat," diffi-

culty in swallowing, and some little stiffness of the jaws will probably be the earliest signs. On examining the pharynx its mucous membrane will be found swollen, œdematous, and glossy, and its surface spotted over with patches of membrane. The tonsils are generally swollen, and spotted also with membrane ; the uvula likewise. The breath is fœtid. Attempts to swallow cause pain and uneasiness. The glands at the angle of the jaw are swollen and tender. There is generally great constitutional disturbance ; fever, a hot and dry skin, restlessness, and prostration. The voice will be pharyngeal in quality. These symptoms all vary greatly in intensity and during epidemics.

The disease now spreads to the larynx. As a rule, this spread *is very gradual, and very insidious ;* and herein, it seems to me, is an explanation of one of the most palpable clinical differences between this variety and primary laryngeal disease described in our last section. In consequence partly of the antecedent blood-poisoning, but chiefly of the very gradual onset of the disease, the body becomes reconciled to its deprivation of oxygen ; hence the suffocative symptoms (which are so prominent and so distressing in the other variety) are less marked, indeed often absent, in this. I have seen the disease far advanced before any surgical aid has been sought, the parents having been misled by the absence of the croupy cough, and the struggling for breath, which are so often looked upon as the essential indications of "croup." Sometimes medical practitioners have themselves under-estimated the gravity of the disease on account of this apparent absence of discomfort in their patients.

In all other respects, the further symptoms would be

identical with those which I have quoted from Dr. West. The results of the disease will undoubtedly be the same, unless we can quickly bring relief.

Remarks on General Treatment.—In deciding on the treatment, we must be guided not only by the general symptoms of any given case, but also by our experience of former cases. It is well known that *all forms of diphtheria tend to the production of asthenia*, and hence our treatment of a case, however slight it may appear to be, must be such as will help *to ward off this danger*.

For this reason I do not regard with favour the very extensive use which is made of antimony in the early stages of the disease. *I especially object to its repeated and continued use.* Children have not infrequently been reduced to a state of exhaustion by this drug, from which it has been impossible to rouse them. I would not say that antimony is always and absolutely contra-indicated; but I think it should be restricted to a very few doses, and that it should only be given in the most sthenic forms of the disease. I believe its only beneficial action is that which is common to other emetics : *it is a purely mechanical one, detaching the membranous exudations by the retching and vomiting to which it gives rise.*

Antimony, moreover, in cases of diphtheria frequently fails as an emetic ; probably the carbonic acid poisoning and the constitutional depression together prevent the physiological action of the drug, and meanwhile the disease progresses unhindered. Then after tracheotomy has once more re-established the vital function, the ingested antimony commences to be absorbed, and to produce the baneful influence which it so largely possesses. Much subsequent diarrhœa and loss of appetite are probably due to it.

No doubt emetics have rendered good service in some cases; and their use ought certainly not to be lightly spoken of. It is, however, well to select those which act as emetics only. I believe sulphate of copper is as good as any, if not the very best. It is rapid in its action, and the local effect on the pharynx is not without its value. Dr. Sydney Ringer, in his work on 'Therapeutics,' says, "A good way to give this salt as a vomit is to administer it in small and frequently repeated doses. It generally produces one copious evacuation, neither purging, nor producing nausea or prostration."

If the disease commence primarily in the pharynx or posterior nares, then the local application of strong hydrochloric acid, as recommended by Bretonneau, is of great service. The acid may be diluted with two or three times its bulk of glycerine, and applied very freely once or twice, or even oftener, according to circumstances. The secretion from a diphtheritic surface is peculiarly acrid and irritating, as may be judged by the excoriation of the anterior nares and upper lip in cases where the nasal mucous membrane is affected. We must therefore endeavour to get rid of it, and, to my thinking, the acid is the best means to that end. I am not able to say *how* it acts, whether it merely substitutes a simple for a specific inflammation, as Trousseau taught; or whether it destroys the micro-phytes which Oertel, among others, regards as the source and essence of the infection; but of this I am convinced, that it is a most efficacious application.

Various disinfectants *may be sprayed* into the throat also. In cases where the fœtor is very pronounced, carbolic acid or sulphurous acid may be used with advantage. Solutions of carbolate of soda, of carbonate

of soda, or of borate of soda, will also be found of great service. The patient may be advantageously allowed to inspire some of the spray (vide Fig. 13, p. 45); for this will lessen the tendency of the disease to spread into the larynx.

As soon as the first symptoms of laryngeal complications come on, the patient should be put into the "croup-bed" (vide page 40), and made to breathe a vapour containing either kreasote, or carbolic acid. The warm, moist air will favour bronchial secretion, and the elimination of the poison. The soda solutions are particularly serviceable at this stage; they seem to render the inflammatory products less organizable.

As regards internal remedies, little need be said, for there is no hard and fast line of treatment; each symptom must be combated as it arises. If there is much depression, carbonate of ammonia with senega (and a little glycerine to make it palatable) will have good effect. Quinine is valuable in all stages of the disease: it may be combined with the perchloride of iron or given alone. Some authors regard iron as *the* remedy: but in young children, I think, it is apt to disagree, if pushed too far. In the earlier stages of the disease, there is sometimes a tendency to laryngeal spasm: then bromide of ammonium will be found useful: it may also be relieved by a few whiffs of chloroform: and the quietness thus produced will further enable us to get a more accurate knowledge of the amount of real mechanical dyspnœa with which we have to deal.

Disinfection.—There is always some danger of a spread of the disease to other persons in the immediate surroundings of the patient. This is especially the case

in private families ; for there is abundant evidence that certain families have a strong predisposition to be attacked by the poison. In view of such a contingency, strict isolation should always be practised ; and a careful search made for the origin of the infection that it may be thoroughly and radically removed. The full use in the house of disinfectants should meanwhile be made. One of the most effective and most simple is burning sulphur. A few grains of powdered sulphur may be thrown on to a heated iron, and allowed to burn. The amount need not be large ; but if it be burned slowly, a strong dose will be borne without any sense of suffocation being produced ; the process may be repeated as often as necessary. In addition to its powerful disinfective property, sulphur vapour seems to act favourably on the disease in some cases. It may be, and I think it is probably by destroying the activity of the disease germs in the patient's body.

The disease, however, once acquired, whatever be its mode of onset, whatever be its etiology, is dangerous to life—among other ways, because of the formation of a fibrinous exudation upon the inflamed mucous membrane of the larynx ; and whatever other properties this membranous exudation may possess, *its mere presence* is a grave source of anxiety. Other measures having failed, the operation must be undertaken for the removal of this false membrane ; whilst, as will be shown further on, the aim of our "after-treatment" should be not only to remove all re-accumulations, but also to prevent, if possible, its re-formation.

CHAPTER III.

TRACHEOTOMY.

At what Period of the Disease should the Operation be undertaken?—The indication for the performance of tracheotomy has already (p. 5) been formulated. It is as follows: *Tracheotomy is indicated in cases of increasing and persistent dyspnœa, when due to disease, or mechanical obstruction in the larynx or adjoining part of the trachea.*

In proposing the above question I have followed somewhat in the lead of other authors. But in answering it I prefer to repeat the indication, rather than attempt to define a period in the disease, as though all cases of this kind ran an uniform course. The amount of membrane deposited in any case varies very much, and the period, no less than the position, at which it is deposited, vary equally. Thus it may be said that there is *no stated period* in the disease at which the operation must necessarily be undertaken. It is the effects, rather than the period, of the disease, which call for it; and the opportune moment must be decided on by the surgeon. I have already referred to *recession of the soft parts of the chest wall, especially in conjunction with more or less complete suppression of voice*, as a valuable test of the amount of obstruction. If expiration should be as audible and as laboured as inspiration, then there is no time to lose; for neither paralysis nor spasm will explain this. Mechanical obstruction is the only cause which can give rise to it.

At the recent discussion on croup and diphtheria already referred to, Dr. Dickinson said, "*If membrane be present and in the larynx, there is little hope but in tracheotomy, which therefore there is no reason to delay.*" Seeing that the statistics of membranous laryngitis, taken collectively, show that the disease is *fatal in about* 90 *per cent.* of the total cases, whatever treatment be adopted, I think Dr. Dickinson's dictum, although somewhat inclusive, will not lead us far astray.

Bearing in mind the comparative harmlessness of the operation, as compared with the extremely fatal nature of the disease in question, as a surgeon I would rather be reproached with having occasionally undertaken an operation which was perhaps *not absolutely necessary, rather than be obliged to look back on fatal cases which my own weakness and hesitancy had deprived of help, while there was yet time to render it.*

Surgical Anatomy of the Trachea.—Although it is hardly probable that the various structures found in front of the trachea will be individually recognized during the performance of a tracheotomy, it may be as well just to bear in mind what these structures are.

Fasciæ.—After the skin and superficial fascia, we come to the deep cervical fascia, which in this part consists essentially of two layers—the superficial and the deep. The *superficial layer* is attached to the hyoid bone above, by blending with the fascia which attaches the two digastric muscles to this bone. It passes outwards towards the sterno-mastoid muscles, at the edges of which it splits so as to encase them. Below, it again divides into two layers which are attached to the anterior and posterior borders of the upper edge of the manubrium sterni, enclosing a little angular space, which con-

tains cellular tissue, and sometimes also a gland. This layer covers the anterior surface of the sterno-hyoid and sterno-thyroid muscles. Beneath these muscles, comes the *deep layer of the cervical fascia*, which is attached to the lower border of the hyoid bone. Passing downwards, it encloses the thyroid isthmus, and covering the front of the trachea, it extends into the thorax to join the anterior layer of the pericardium. Laterally it forms the sheath of the great vessels of the neck.

Veins.—The next important structures are the anterior jugular veins, which are very irregular in their course and termination; they are placed immediately superficial to the sterno-hyoid and sterno-thyroid muscles, and are frequently connected by a transverse branch, at the lower part of the neck. Normally there should be one on each side of the median line, but not infrequently one is much larger than the other. Sometimes the left vein crosses over and terminates in the right one.

Surrounding the thyroid isthmus is a plexus of large veins, opening above into the superior thyroid, and below into the inferior thyroid veins. These latter are of considerable size, and one may lie immediately in front of the lower part of the trachea: they open into the innominate veins.

While speaking of veins, it may be well to remind the operator that, *in the child*, the left innominate vein occasionally runs above the level of the sternum, and has more than once come into sight during a tracheotomy.

Arteries.—There are two arteries in this region, the distribution of which is important and must be referred to. These are the crico-thyroid, a branch of the superior thyroid, and the thyroidea ima, an irregular branch either from the aortic arch or from the innominate.

In the child, the innominate artery is closer to the left carotid at the lower part of the neck than obtains in the adult. There are occasional abnormalities in the origin of the great vessels from the aorta, which may complicate the operation seriously; but for these, no definite rules could be laid down.

Muscles. — The chief point to remark is, that the sterno-hyoid muscles are not in contact in the median line. At their attachment to the hyoid bone there is an interval of about one quarter of an inch, and as they descend they gradually get further apart. It is well to remember this fact, as it is a strong argument in favour of making an exactly median incision.

Thyroid Gland. — The isthmus varies a good deal both in its width and in its position. In the adult, it should lie over the second and third rings; but in children it is generally somewhat higher. I have frequently seen it covering the cricoid cartilage. In girls the isthmus is usually longer than in boys.

Thymus Gland.—This gland is sometimes largely developed and persistent in very young children, and in attempting the lower operation, has been seen to be present in the wound.

Cellular Tissue.—Some loose cellular tissue is also found between the trachea and the structures in front of it, into which pus and exudation products from the trachea occasionally find their way after the operation. Reference will be made to this under the heading of "Complications."

Trachea.—The trachea is exceedingly movable, and for very obvious reasons. In attempting to open it, this fact should be borne in mind, and also that it is especially liable to be drawn away from the median line if

retractors are used during the operation. On referring to Fig. 5, page 31, which represents a vertical section from before backwards, its direction downwards and backwards will be better appreciated, and its relation, as regards depth, to the surface of the neck will also be seen. Thus in an adult it is at least one inch deeper below the level of the thyroid gland than at the cricoid cartilage. I would also just remind the reader of the great development which the larynx and trachea undergo after about twelve years of age. This is out of all proportion to the rest of the body, and has important bearings on all operations which involve these parts.

"During childhood, the growth of the larynx is very slow. Richeraud found that there was scarcely any difference between the dimensions of this organ in a child of three and in one of twelve years of age." *

Details of the Operation.

Ought Chloroform to be used?—I have no hesitation in answering this question in the affirmative. After some considerable experience, I can truly assert that I have never seen any ill effects produced by its use. There is, not unnaturally, some little struggling when the inhalation is first commenced; the child holds its breath, the face and lips become blue and congested, and the veins of the neck get full. But very similar results follow when the operation is done without chloroform, for the pain causes the child to struggle, and it also resents being held in a constrained position.

If the chloroform be slowly and carefully administered, a child may be "sent off to sleep" without any trouble or danger. For this purpose *a few drops* of chloroform

* Quain's 'Anatomy,' 8th edit., vol. ii. p. 294.

should be sprinkled on a handkerchief or piece of lint; it should then be held to the child's face by degrees. Two or three whiffs under these circumstances suffice to make the child drowsy, after which the inhalation can be proceeded with more rapidly. It is the choking sensation of a large dose of chloroform, *suddenly* applied, which causes the struggling.

Using this precaution, I believe that chloroform may be safely administered to children with croup. Indeed, I have more than once seen the respiration become deeper and quieter after a few inhalations, and a state of repose brought on which eminently facilitates an operation, never an easy, often indeed an exceedingly difficult one.

Value of an Assistant.—By way of preliminary, I would just say that, whenever it is possible, the surgeon will do well to have an assistant with him. It is true that one should be prepared to undertake the operation at any moment single-handed; but this does not lessen the value of a good assistant, whenever it is possible to have one. Considering all the circumstances, there are few operations where skilled help is more welcome than in tracheotomy.

Instruments.—It may be as well to say a few words about the instruments. Very few suffice. I think it is desirable to keep them in a small portable case, so that they are always ready; for the surgeon is mostly summoned in a hurry, and if he have to collect his instruments, it is not improbable that some one or other may be left behind.

As essential, may be reckoned :—

One small scalpel.

Two pair dissecting forceps.

One trachea dilator.
Two or three trachea tubes ; and tape.
An elastic catheter. Some feathers.

As useful, may be added :—

Another scalpel.
A fine key-hole saw.
Scissors.
Artery forceps. One or two "bulldogs."
Two blunt hooks.
One sharp hook.
Laryngeal brushes.
The "automatic retractor."
Variety of tubes. Needles. Ligature silk.*

The Operation.—The various instruments required should be laid out, and the operating table placed so as to secure the best possible light. The child is then placed upon it. Chloroform (if this have not been previously done) is now administered. When the narcosis is completed, the patient must be got into position. *The point to secure is the greatest possible prominence for the neck.* This is best accomplished by laying the child on its back, and putting beneath the shoulders *a small round cushion* (one may extemporize a very useful cushion by rolling an empty wine-bottle in a towel). It matters little how it is accomplished, provided the end be attained. I may just say, that I have myself failed, and have seen others fail also, to get the neck into a suitable position from using too large a cushion.

The trachea may be opened either above or below the isthmus of the thyroid gland. These operations are

* A very neat portable case, containing all the above instruments, has been made for me by Maw and Son, and by Krohne and Sesemann.

respectively called *the high* and *the low* operation. In young children the high operation is generally selected, because it is *very much the easier*. It would perhaps be more rightly called a *crico-tracheotomy*, from the frequency with which the cricoid cartilage is incised, either accidentally or designedly. The low operation is more difficult, because of the greater relative depth of the trachea, the larger size and number of veins, and the vicinity of the great arterial trunks. The neck of a child is exceedingly short; it may almost be said not to have any neck at all. For these reasons the low operation should be discarded, unless some special reason exist to indicate it.

The child's head being well thrown back over the cushion, so as to make tense the tissues in front of the neck, and also to bring the laryngeal landmarks into greater prominence, and being held quite straight by a nurse, the operator, standing on the right of the table (*vide* Fig. 1), with his left fore-finger feels for the cricoid cartilage. Even in a fat neck this may generally be made out without difficulty. A longitudinal, mesial incision is then made about one and a half or two inches long, in such a way that the cricoid corresponds to its mid-point. The incision should be a bold one, so as to include the deeper fasciæ as well as the skin. I believe this facilitates the operation; for probably at no other stage of the proceeding can one better than now appreciate the median line, where, as I have shown, there are really no other structures to cut through, except perhaps the thyroid isthmus in exceptional cases.

It will be seen, therefore, how advantageous it is to

keep *accurately* to the median line of the neck, if one would not complicate the operation.

In exposing the trachea, I always adopt von Langenbeck's dissecting method; it does away with the need of



FIG. 1 represents the arrangement of the Operating Table, &c.

retractors. This method consists in using two pairs of dissecting forceps, after the first incision has been made. One pair is held by the operator, who seizes hold of any tissue that needs dividing. His assistant, standing on the other side of the table with the second pair of

forceps, lays hold exactly opposite. The structure is then slightly drawn forward, raised from the wound, and cut through. This is repeated until the trachea is bared. I must caution against making a funnel-shaped dissection: by this I mean, making the deeper incisions gradually shorter and shorter (as compared with the external one) until the wound assumes the shape of a funnel.

Unless in skilled hands, retractors are dangerous aids; for they are apt to displace the trachea itself, and thus lead to its being incised laterally rather than in the median line. If retractors are used, be sure that retraction is made uniformly on the two sides. The double instrument figured below is the best for the purpose.



FIG. 2.—The Double Retractor.

While on this subject, I would just allude to a little "automatic retractor" which I have had made. I devised it, after having been once or twice suddenly called upon to perform tracheotomy, when there was no one

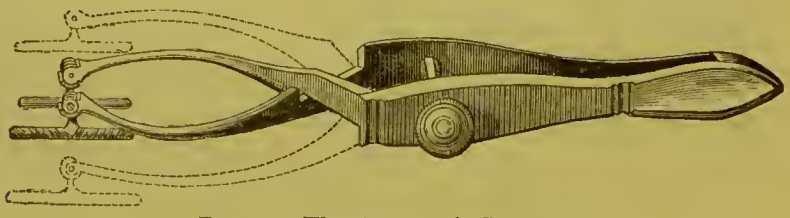


FIG. 3.—The Automatic Retractor.

near to assist me; and I need hardly say it is a very awkward operation to do alone. Under these circumstances, the "automatic retractor" (Fig. 3) will be found useful. The incisions into the soft parts having been

made, the blades of the retractor are introduced closed (like an eye speculum), and are then opened to the required extent, and the screw adjusted.

It does not take the place of a good assistant, but it may occasionally prove serviceable, when an assistant is not at hand.

The isthmus of the thyroid gland may be found in the way; it may be got rid of either,—first, by depressing it with a blunt hook or retractor; second, by deliberately cutting through it; third, by Bose's method, which consists in making a transverse incision across the cricoid cartilage, so as to divide that layer of cervical fascia, by which the isthmus is bound down. A director is then passed in, and the thyroid gland together with its vessels are easily and rapidly separated from the trachea, and may then be depressed.

The first method, in my hands, has generally sufficed. As for the second, I believe it may fearlessly be done in a majority of cases. Of course, if the isthmus be unusually large or vascular, depression in one or other of the ways described may be previously tried. I have never tried Bose's method on the living subject, simply because I have never had occasion to do so.

The cricoid cartilage and the two or three upper rings of the trachea having been exposed, the surgeon may now open the trachea. This should be done *from below upwards*. The space, especially in a young child, is never very extensive, and it may be requisite to cut the cricoid cartilage in order to secure sufficient room for the tube. Indeed, I am inclined to believe that it is always advantageous to cut the cricoid. The crico-thyroid membrane may also be nicked without danger. For it is very important that the opening be ample, or

otherwise the tube will not fit in comfortably. After the trachea has been incised, a dilator is inserted, and the edges of the wound are thus kept open. In common with Mr. Holmes and other writers, I would strongly recommend that the trachea be laid quite bare before it is incised. Much of the difficulty of introducing the cannula depends on not observing this rule.

In a majority of cases, there will be more or less hæmorrhage. Unless very profuse, it may be disregarded. If arterial, the artery may be tied; but if venous, it almost invariably stops as soon as respiration is freely re-established. If, owing to some abnormal arrangement of the vessels, an unusual or dangerous amount of hæmorrhage should occur, it must be treated *secundum artem.*

Having arrived at this stage, all immediate danger of suffocation will have passed. There will be no further need of chloroform, and the child may be allowed gradually to wake up. *The trachea being now held open by the dilator, the surgeon proceeds to what is the most important part of the operation*, viz. the clearing away of the exudation, which has been the *cause* of the laryngeal obstruction. This is accomplished very effectually by means of a feather. It must be previously soaked in a warm solution of carbonate of soda: then it is passed into the trachea, and twirled about, so as to loosen, as well as entangle, the membrane. This gives rise to a little cough, and thus the membrane is expelled. Next, the feather must be passed upwards into the larynx, through the glottis, and into the mouth, where it can be seen, frequently with shreds of membrane hanging to it. *It is very important that all the*

membrane, as well as mucus, be thoroughly got rid of; for membrane is dangerous, not only because it offers a mechanical hindrance to respiration, but also because it is infectious to adjoining and contiguous structures. Another reason why the glottis should be carefully freed from all foreign matter is, that its presence here is a source of cough and irritation, which distress the patient. Under ordinary circumstances, we can voluntarily clear the glottis of any irritating matter by coughing—a reflex process set up for the purpose. But after tracheotomy this is impossible, for the air is diverted through the tracheal wound. If it be found that the membrane is very tough or very adherent, or if it have already extended downwards below the point of the incision, it will be well to spray into the trachea some 20 gr. solution of carbonate of soda (*vide* page 45). This must be done for several minutes. It ought to give rise to some coughing; after an interval of a few minutes, the feather may again be used. If it still be found impossible to get out the membrane, an elastic catheter should be introduced, and aspiration be made by the mouth.

As a rule, this aspiration may be undertaken without any fear; but there might be cases, as for instance

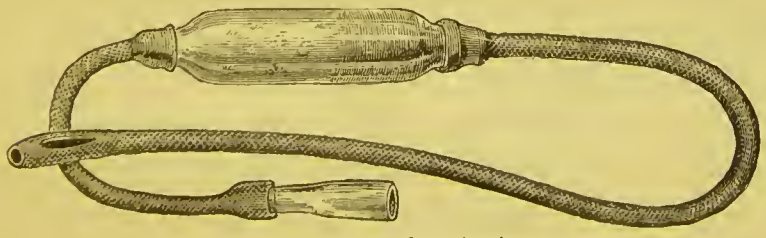


FIG. 4.—The Trachea Aspirator.

during epidemics, in which the proceeding would be fraught with danger. I have therefore devised a little "trachea aspirator," which is figured above.

It consists of a small glass cylinder, to one extremity of which is fixed a flexible hollow tube, and to the other a glass mouthpiece. When it is going to be used, half fill the cylinder with carbolized cotton wool. This will act as an effectual filter, and, while obviating all risk of self-infection, it will give one all the advantages of this method. It is much preferable to using a bottle aspirator, or any other kind of suction apparatus. The advantage of using the mouth is obvious; the operator can more readily and more delicately adjust the amount of force to be used; he *feels* what he is doing, and is more expeditious and more certain in his results. *The larynx and trachea having been well cleared out, the tube may now be inserted.*

It is impossible, I think, to give any fixed scale of sizes for the tubes, for the trachea varies much in children of the same age; its dimensions correspond with the development rather than with the age of a child. I should in all cases recommend the largest tube which can be got into the trachea without having to use violence in its introduction. The surgeon should be provided with a variety of sizes, not only as regards calibre, but also length.

The curve of the canula is a matter of some importance. *The ordinary quarter-circle tubes do not correspond with the natural direction of the trachea*, and hence their use is contra-indicated on anatomical grounds. This may be seen by reference to the annexed figure, which represents a vertical section through the trachea, with an ordinary tube in dotted outline, *in situ*.

The lower extremity of the tube tends to impinge on the anterior wall of the trachea, and it will subsequently be shown that this is attended with many inconveni-

ences, and even with grave risks. The drawing below is copied from Braune's Anatomical Atlas, and its correct-

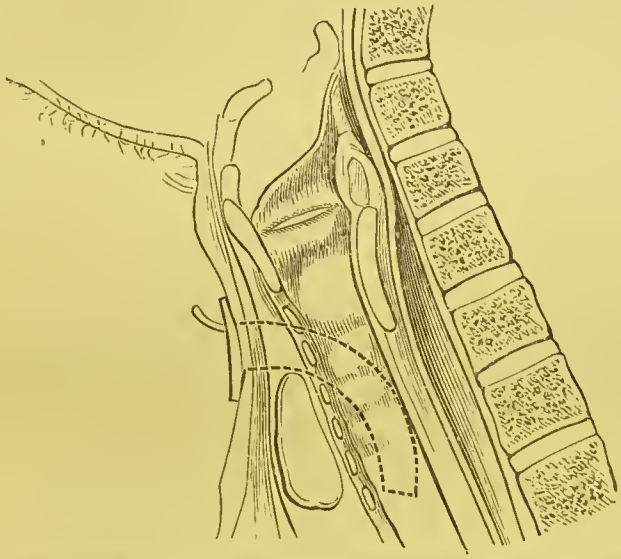


FIG. 5 —Outline figure of the Trachea, showing its direction, and also an Ordinary Tube *in situ.*

ness was tested by a preparation which I recently made at University College, with the aid of my friends Mr. Godlee and Mr. Ottley.

In place of these quarter-circle tubes I would propose an angular one, the shape of which corresponds more nearly with the direction of the trachea. I have now used it in several cases, and can speak with confidence of its value and utility.

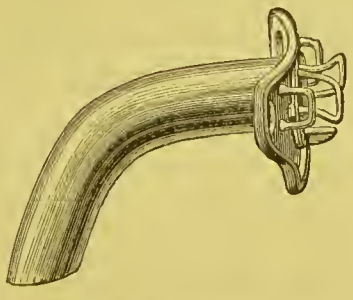


FIG. 6.—New Angular Tube.

The *length* of the tube is the next point of importance: if the direction of the tube correspond with that of the trachea, one of the inconveniences of long tubes will have been

abolished; for however long, they cannot produce any ulceration on the anterior wall of the trachea, as formerly did the quarter-circle tubes. The annexed figure, also from Braune's Atlas, shows one of these "angular tubes" *in situ*.

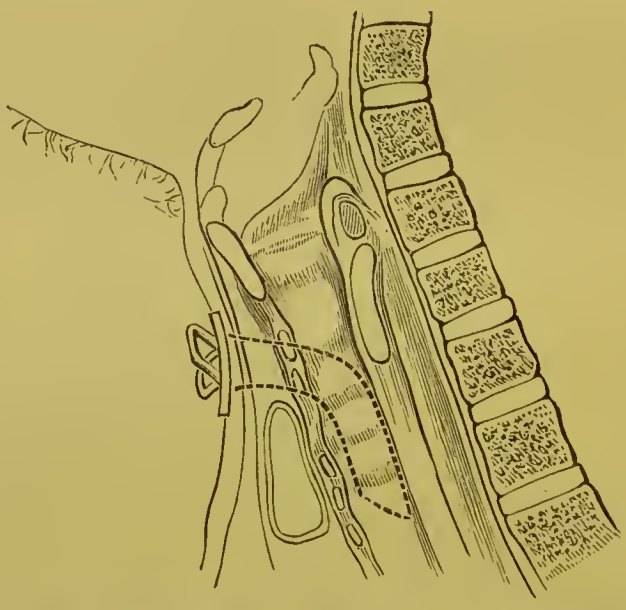


FIG. 7.—Outline figure of the Trachea, with an Angular Tube *in situ*.

But under any circumstances, it is very desirable that the tubes should be as short as possible; for it is a matter of observation, borne out by Dr. West among others, that our patients breathe more easily through short than through long tubes: that is to say, given a certain calibre, the muscular exertion required to draw in air and expel exudations is less and less, in proportion as the tubes are short.

Thus, I recommend the largest sized tube that can be got into the trachea without violence, and the shortest that is consistent with safety. In gauging the calibre, always look at the inner tube, and remember that the smallest diameter determines the size. Tapering tubes

are to be avoided; for while they necessitate a larger opening into the trachea, they do not afford more ample breathing space.

While speaking of the tube, I must not forget to mention the value of a movable collar. The invention is due to M. Roger, of Paris; it is undoubtedly one of the most important modifications which the tracheal canula has ever undergone. Fig. 8 shows the mechan-

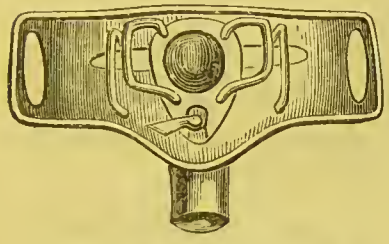


FIG. 8 shows the mechanism of the Movable Collar.

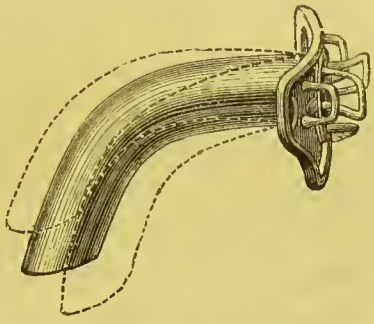


FIG. 9 shows the advantages of a Movable Collar.

ism of this movement, and Fig. 9 shows, by dotted lines, how the tracheal portion can alter its position during the various movements of the larynx, and of the neck.

A suitable tube having been inserted, and tied in with tapes round the neck, the patient may be put back to bed.

While speaking of the canula, I would say that great care should be exercised in its manufacture. It ought to be carefully finished: its extremity especially should be perfectly smooth, and its edges bevelled inwards. The inner tube should glide easily within the outer one, so that, when in use, the trouble of removing it for cleaning, and of replacing it afterwards, is reduced to a minimum. The interior of the inner tube may advantageously

be polished; for this facilitates the removal of all impurities.

Mr. Morrant Baker has recently introduced a flexible tube: there can be little doubt that it will prove useful in many cases. Mr. Baker believes that these tubes will materially lessen the danger of intra-tracheal erosions, which sometimes follow on the use of silver tubes. Mr. Walsham has further added to their value by suggesting a pilot which facilitates their introduction into the trachea.

This chapter would hardly be complete without mention of some of the dangers which may occur during, as well as immediately after, the operation.

From one of many causes or from a combination of circumstances—either because permission could not be obtained to operate earlier, or because the surgeon was not at hand, or in consequence of a sudden accession of dyspnœa, or in consequence of accidents and delay during the operation—the patient may cease to breathe and to all appearances may seem dead, before the operation can be completed. What should the surgeon do under these circumstances? I strongly advise that the trachea be opened, and cleared out, and then that systematic, steady, and prolonged efforts be made to restore the patient. I have several times seen cases apparently brought to life again, even after some interval. *It is important to bear in mind that our efforts are not likely to succeed, unless the trachea be patent as well as opened.*

Occasionally, blood in considerable quantity may find its way into the trachea. It may be in consequence of wounding some unusually placed vessel, or from having

incised the trachea before it has been fully exposed. Sometimes, in very urgent cases, the surgeon loses a little of his calm, and makes his tracheal incision on one side, and after having withdrawn his scalpel, he is unable to get in either the tube or the dilator. Thus, considerable quantities of blood may be drawn into the lungs, and by coagulating may add to the danger and distress of the patient. In such cases, aspiration is clearly the remedy, and the little instrument figured on page 29 may advantageously be employed.

Another untoward result of a non-median incision in a partially exposed trachea is *surgical emphysema.* I have seen the entire neck, and even the face, swell up to double their proper size in consequence of an escape of air from the trachea into the surrounding cellular tissue. When we consider that this air comes from a diseased trachea, and that it is teeming probably with diphtheritic infection (germs), we can easily conceive how dangerous such emphysema may prove, and we shall appreciate how necessary it is to avoid it. In these cases, I believe it is well to disregard all previous incisions, and to make a fresh one in the median line, quite irrespective of them ; for as soon as a free opening is once established, these smaller openings close spontaneously, and no further escape of air takes place.

It sometimes happens, even after a well-performed operation, and, notwithstanding a careful incision of the trachea, that the insertion of the tube is not followed by that relief which we always so anxiously look for. The secret is often to be found in the fact that the trachea has not been sufficiently cleared out, or that the tube has actually been inserted between the tracheal wall and a complete membranous cast which it has

but partially thrust aside. Indeed, I have an anatomical specimen illustrating how this may occur. The too anxious surgeon often feels that his patient is not safe until the tube is inserted, and he hurries to accomplish this. But let it be remembered that, with a dilator in use, immediate danger need not be apprehended; while on the other hand, a tube inserted too soon may prove but a false security.

I must also just refer to the possibility of the two bronchi being more or less occluded by shreds of loosened membrane (after the use of the feather) which have been drawn in during inspiration. Such a condition may be suspected when air does not enter the chest freely, and where the physical signs do not point to consolidation or disease of the lung itself. In such cases, the tracheal aspirator should be introduced, and an attempt made to remove the obstruction.

As regards this apparently rough handling of the interior of the trachea, I will only just express my own conviction that it may be undertaken and carried out freely without any hesitation. I believe this treatment is infinitely less irritating and less dangerous to the trachea than the sojourn of membranous exudation upon it. I have never had occasion to regret carrying it out too freely, but I have frequently blamed myself—when too late—for not having sufficiently acted up to my precepts. Should the operator ever feel in doubt, let him call to mind and compare the present, with the former treatment which surgeons adopted towards the peritoneum; and then hesitate no longer.

CHAPTER IV.

DETAILS OF AFTER-TREATMENT.

Nursing.—A well-trained nurse to take charge of the patient is most essential. Although a few cases recover without having a nurse, yet a large number die, chiefly in consequence of insufficient nursing. Neither good intentions nor devotion suffice. The nurse in charge of a tracheotomy needs the special knowledge which special experience alone can give. For she has to deal with an insidious disease, affecting the most vital function of the body.

An unrecognized plug of membrane in the tube may suffocate the patient in a few seconds, before other help can be summoned, although the danger could be removed with a feather. Again, the tube might get displaced by accident; a trained nurse, even if she could not replace it, would know how to use the dilator, and thus save her patient until the surgeon could be found.

But there are many other duties, hardly less important, which can only be trusted to a good nurse. Cleaning the tube, the regulation of the steam apparatus, the administration of medicines, and last, but not least, the administration of nourishment. On all these points the nurse must be full of resources, apt, and ready to do the right thing at the right moment. She must anticipate her patient's wishes, and instinctively feel the little troubles and sufferings which he can no longer give utterance to. Above all, her supervision must be

constant, while her success will depend on her appreciation of the right moment when to interfere and when to stay her hand.*

Chief Indication in After-treatment.—As the chief object of the operation has been the removal of a mechanical hindrance to the admission of air into the lungs, so our chief indication as to after-treatment is the prevention of any subsequent recurrence of this obstruction.

It is almost needless to point out that the false membranes in these cases have a marked tendency to re-form, often more than once, after removal; and hence it behoves the surgeon to be constantly on the look-out for the earliest symptoms which betoken such recurrence. I have already expressed my opinion that membrane is dangerous, not only because it mechanically interferes with the admission of air into the lungs, but also because it is infective. Its continued formation is, moreover, *the visible proof of an active infective process* still going on; and there is an ever-increasing danger of what is at first a purely local disease becoming a general disease. I again refer to this point because it ought ever to be present to the surgeon, and should constantly influence his treatment.

Value of Steam.—Various means may be used to facilitate the removal of membrane. I have already referred to the use of a feather at the time of the operation. Perhaps the most important aid, however, is the *inhalation of steam.* For this purpose the patient's bed

* The surgeon must not forget that a nurse requires rest and fresh air, especially while in charge of diphtheria patients. A stated amount of sleep, and of exercise in the open air, are as essential to her health as health is essential to the proper discharge of her duties.

should be surrounded with curtains. The plan I found in use at the Hospital for Sick Children seems to me the most suitable. A rod (of wood or iron) is strapped to each one of the four legs of an ordinary cot; these four uprights are then connected together by four cross rods, as in Fig. 10. In this manner the cot is converted into

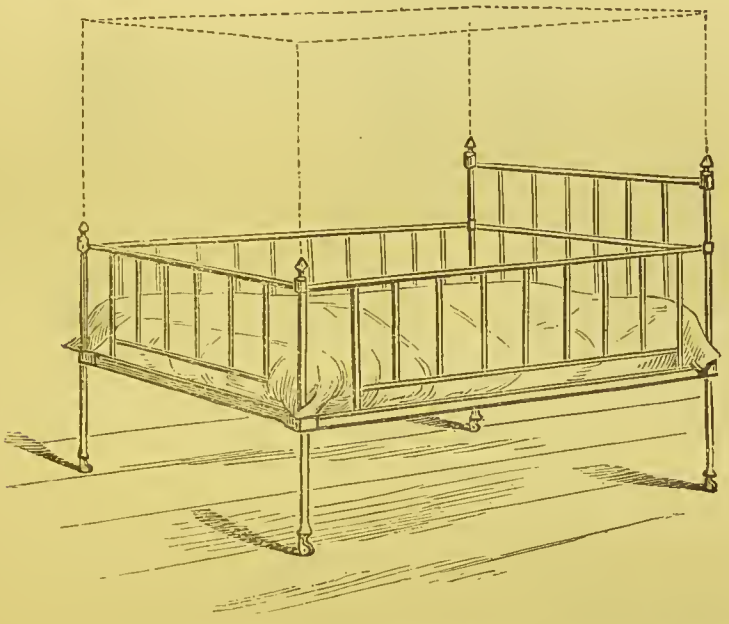


FIG. 10.—An ordinary Cot. The dotted lines represent the movable iron framework.

a four-post bed. Sheets are then thrown over this extemporized framework, so as to cover in the cot on all sides but one. The advantages of this kind of bed, whether it is used in private houses or in hospital wards, are obvious. In the first place, *it isolates the patient*, and gives us greater control over his surroundings than we could otherwise have. Next, we can regulate the temperature of the air, and the amount of steam, and further, we can make the steam the vehicle for various kinds of medication—antiseptics, anodynes, stimulants, or

expectorants, according to the requirements of the case—and this, too, without in any way interfering with the comfort of the other occupants of the room, or the ward, as the case may be.

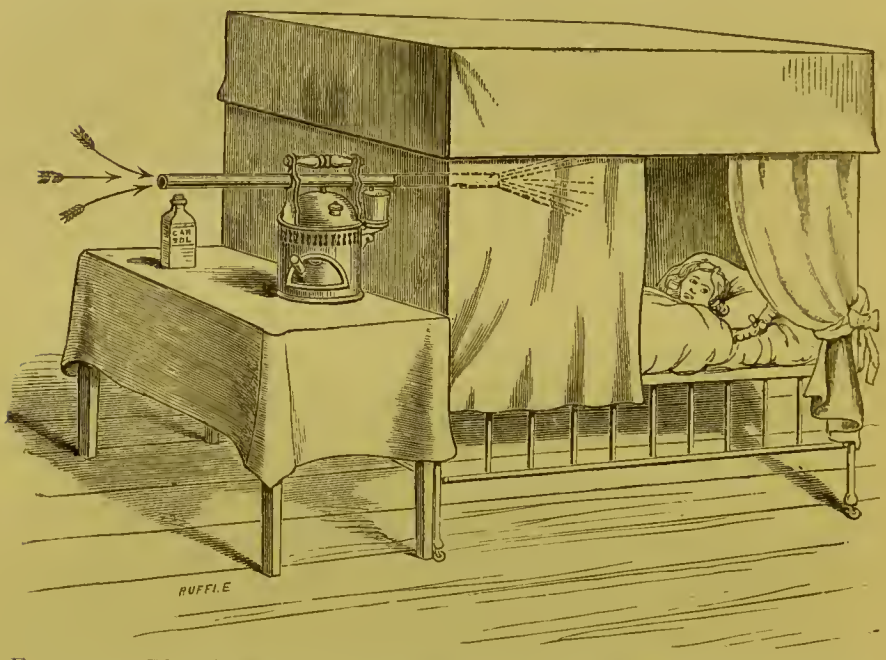


FIG. 11.—The Croup Bed complete, with the steam apparatus. The arrows indicate the current of air which is being insensibly introduced along with steam.

A small steam apparatus is kept boiling on a table close by, from which a certain amount of steam must be conducted into the bed, as in Fig. 11. The framework can be extemporized out of wooden laths, or in any other way; but for the sake of convenience, I have designed a light, portable, expanding iron frame, which will adapt itself to any bed, and which the surgeon can carry with him, as part of his croup *armamentarium.**

* It can be obtained of Messrs. Allen, Marylebone Lane, London, the manufacturers also of the croup kettle.

Even if the case is in a separate room, it is a great advantage to have such a means of isolating one's patient; for, thanks to the protection of the curtains and the warmth supplied by the steam apparatus, the window can be opened without any fear of draughts, and a free ventilation kept up. This is of importance both to the patient and the nurse.

If the case is in a hospital ward, in which there are other patients, the ward can be ventilated as usual; and if it happen to be a children's ward, the danger of infection is thus materially lessened.

The plan (in use at some hospitals) of drawing the bed close up to the fireplace, surrounding it with the ordinary ward screens, and then covering them in with blankets, does not seem to me so good a plan as the one I have just recommended. For it is more difficult to regulate the temperature, and it frequently deprives the patient both of the fresh air and light, which are so necessary for his recovery.

In order, however, to secure the full benefit of steam, and especially when using the "croup bed" just described, it must be applied scientifically.

For this purpose the ventilating croup kettle is the most useful. It was made, at my suggestion, on the principle of the ingenious "steam draught inhaler" invented by Dr. Lee, differing from it chiefly in size, and in one or two minor points, which, while they render it more convenient as a "croup kettle," lessen its value as an inhaler.

Fig. 12 shows the mechanism of this kettle; for it is essential to understand the principle on which it works, or otherwise accidents may possibly occur.

A A is the combined air and steam tube, B represents

the nozzle, through which steam, at high pressure, escapes into the tube A. Owing to the velocity with which the steam issues, the air in the tube is driven out at one extremity, while fresh air rushes in at the other

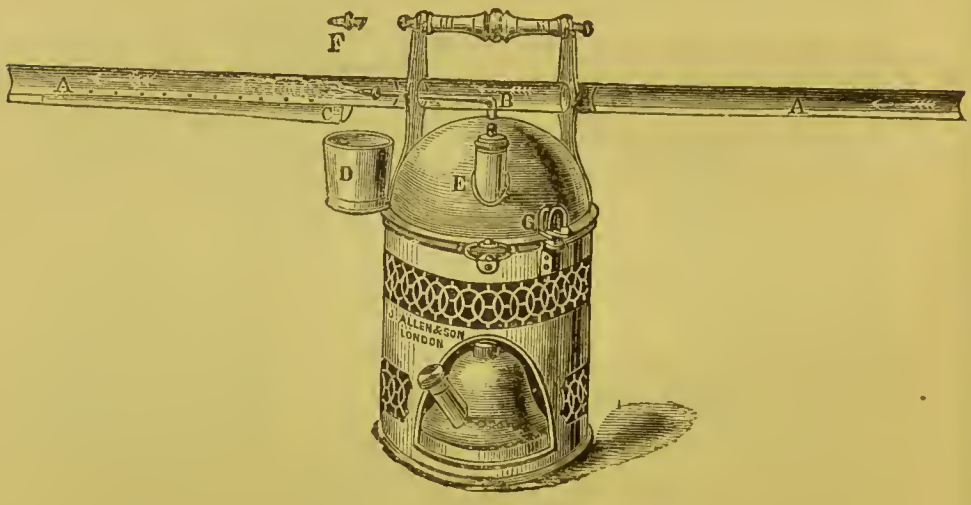


FIG. 12.—The Croup Kettle.

to replace it ; thus a constant current of fresh air is kept up, the amount varying with the quantity of steam. In the course of a short time the tube becomes heated, and the air in passing through also becomes heated. *A constant current of fresh, warmed, moist air is thus supplied.* The amount is regulated by the size of the flame used.

The following general instructions as regards the kettle will be found useful :—

See that the steam nozzle is patent, or otherwise an accident may occur. The boiler should never be more than three-quarters filled. Boiling water should be used for the purpose. The amount of flame will vary with the amount of steam required. If any medicaments are used, they must be mixed with a little warm water in a measure, and then poured into the kettle with the hot water. Always remove the lamp before refilling or

opening the boiler. Be careful that it does not boil dry. If any resinous substances have been used (such as benzoin), let the kettle be carefully washed with strong soda and water before it is put away ; the steam nozzle also should be screwed off and carefully cleaned. When not in use, the kettle should be kept empty and dry.

The amount of steam required varies with the individual case. Its *indication* may, I think, be formulated thus :—*The less there is of tracheal secretion, the more is steam needed ; and the converse. An excess, however, is in all cases to be avoided,* as it tends to depress the patient. Steam acts on the bronchial mucous membrane much as it acts on the skin ; it encourages secretion ; the secretion tends to loosen the membranous exudation, and so bring it within the current of the expired air, by which it is expelled. It may be made the vehicle of important medication, of which not the least important is disinfection.

Disinfectants.—The importance of systematically using disinfectants cannot be over-estimated. There is abundant evidence to show that diphtheria not infrequently arises from exposure to drain emanations. This, I think, is not to be wondered at, if the exudations of patients suffering from diphtheria are thrown away without being thoroughly disinfected, just as is now done with the stools of typhoid patients. So, too, *with the air they breathe.* By adding a little carbolic acid or creasote to the water in the croup kettle, a disinfecting atmosphere can be supplied to them, which will tend very much to lessen the chances of a spread of the disease.

Creasote, besides being disinfectant, has a stimulating influence on the bronchial mucous membrane, and

promotes secretion. The olcum pini sylvestris belongs to the same class, and is an aromatic cxpectorant possessing antiseptic properties.

Sedatives.—Under certain circumstances, it may bc well, while keeping up a gentle disinfecting vapour, to apply from time to time sedatives. There is often a troublesome cough, which distresses the patient. In such cases, Dr. Lee's Inhaler will be found of great service, for more highly medicated steam can be applied directly to the trachea, than is possible with the simple croup kettle. Thus the compound tincture of benzoin (℥j ad ℥j) when inhaled is an excellent sedative. It may be combined with a few drops of chloroform, or given alone, according to the requirements.

The Value of Solvents.—Next in importance to steam come solvents,—drugs the action of which is to liquefy membranous exudations. *Soda and potash* are the most valuable of this class.* If portions of well-formed membrane be placed in different test tubes, severally containing a solution of saccharated lime, of carbonate of soda, of carbonate of potash, and of distilled water, very marked differences in result will be obtained. The lime solution will quickly dissolve the membrane, the soda and potash solutions also, but they will require a somewhat longer time; the distilled water will not produce any effect for several days, and then only by leading to decomposition. In any given case, where it is wished to liquefy and disorganize the membranous exudations, one or other of the solutions may be uscd. Thc lime, though more active in thc test tube, is so quickly

* Besides this solvent effect of alkalies, it is said that "very dilute alkalies" favour ciliary action, as also does heat.—FOSTER, 'Text-book of Physiology.'

altered by the carbonic acid in the expired air, that it becomes inert in the trachea.

On the whole, and after many experimental trials, I am inclined to regard the soda solution (10–20 grs.—ʒj) as the most generally useful. It may be sprayed in front of the canula, in such a way that the spray is inhaled; this may be continued for five or ten minutes at a time, and repeated at longer or shorter intervals as circumstances dictate. Fig. 13 shows a convenient arrangement for spraying a child.



FIG. 13.—Mode of using the Spray.

The child is seated on the nurse's knee, and is then covered with a waterproof in order to protect its dress from wet and damp. A small hand spray suffices admirably; or a steam spray may be used, if there is one ready to

hand. After each spraying let the feather be well used, so as to detach and get rid of any bits of loosened membrane. The soda solution is useful, I believe, not only because it liquefies any membrane with which it comes in contact, but also because it renders the exudation material less organizable.

Suction.—There is another means by which false membranes, inspissated mucus, &c., may be got up from the trachea, should neither steam nor the solvents, nor the use of feathers suffice. It may be *sucked out.* I have already referred to this method in describing the operation (vide page 29), but think it well to again mention it under the "after-treatment," where it is generally most required. Obstructed breathing may frequently be relieved by these means, the disease be followed deep down into the chest and success obtained where, without them, death would be inevitable.

From within a short time of the operation, there will probably have been some secretion from the tracheal wound, and if there is much cough, the mucus together with the air will give rise to a "rattling" sound, which at first causes anxiety to the attendant. This, however, is not an unfavourable sign. Whenever much mucus is being expectorated, it should be cleaned off the tube with a sponge, or the tube itself may now and then be cleaned with a feather. *Be careful, however, not to worry the patient with too much attention.*

Speaking generally, I would say that a *free secretion* from the trachea *is not an unfavourable sign.* Indeed, it will be seen that one object of the treatment just proposed has largely been to encourage secretion in the first place, and to secure its removal in the second.

On the other hand, a *dry tracheotomy* must generally be regarded with anxiety. The dry cases are usually exceedingly tolerant of interference, and a feather may often be inserted into the trachea without its giving rise to any reflex cough. This, too, is a very unfavourable sign, and should always induce a most guarded prognosis. Our efforts to promote secretion must be redoubled; the child's general condition should be carefully examined, and any special indication met by a corresponding effort to overcome it.

Changing and Cleaning the Tubes.—We next come to consider the question of changing and cleaning the tracheal tube. How often does it require cleaning? is the first point one naturally thinks of. The inner tube must be taken out every hour or two, and cleaned with a feather and warm water. If the mucus is very tenacious, the soda solution will be found useful, and may be used instead of plain water. If the patient's temperature is very high, the tube will require more frequent cleaning; for the metal tube gets heated by the body, and the secretions are more apt to inspissate in consequence. The exterior tube also ought to be cleaned after the lapse of twenty-four to thirty-six hours. This is an useful proceeding for many reasons, for it allows us to detect the earliest signs of unhealthiness in the external wound, as well as to apply the appropriate remedies. Sometimes the tube after its removal from the trachea will be seen to be blackened. If such is the case let the wound be carefully examined. Each of the black patches will be found to correspond with some unhealthiness or sloughing, which must be treated accordingly. Indeed, I regard this oxidation of the silver tube as an important aid in diagnosis, for it often points out the earliest

manifestation of a morbid process, which if not checked at once, may prove of great danger to the patient. There is not much difficulty, as a rule, in re-introducing the tube; but it is always well to have a dilator at hand, in case difficulties should present themselves. I generally keep a second tube ready, identical in all respects except length, with which to replace the one removed; and so alternate from day to day as circumstances suggest. This is one method of preventing erosions of the tracheal wall. Another advantage of taking out the exterior tube is the opportunity which it affords for testing the breathing power throughout the larynx. It is always well to commence these trials early before disuse has crippled the muscles which open the glottis.

The re-introduction of the tube, as I have just said, is not as a rule difficult, for the incised tissues in front of the trachea all become glued together with inflammatory lymph; and a tunnel leading directly into the trachea is quickly formed. It is in itself a good sign, when this adhesion takes place, for while it facilitates access to the trachea, it prevents bagging of secretions among the intermuscular planes, to which reference will again be made under the heading of "Complications." In some cases, however, no such adhesion takes place, or it takes place much more slowly, and then the re-introduction of the tube is proportionately more difficult. In these cases it will be necessary to have the dilator at hand, and proceed as deliberately, and much in the same way as at the operation. I do not think that this asthenic condition of the wound should interfere with the proper changing of the tube; indeed, its condition can never be rightly gauged until the first dressing has been thus carried out; and with the possibility of finding the way

into the trachea not yet well defined, it is always wise to do this first changing of tube with the child on the operating table, and one's instruments all ready to hand. In a few cases, the edges of the wound may be found in a very unhealthy condition, or deposits of membrane may be seen; we must treat them on general principles, not forgetting what has been said on *the importance of destroying all local manifestations*, whenever and wherever met with.

Permanent Removal of Tube.—Finally, we have to consider the permanent removal of the tube. If it is regularly taken out, as recommended, for cleaning purposes, we shall be able to test the condition of the glottis from time to time; and it is well to do so, and *to commence our trials about the third day.* It will be evident that we cannot make satisfactory trials so long as the tube is in the trachea, even although the tube may have a window in its posterior wall. Some surgeons simply place the finger tip over the orifice of the tube; I much prefer to remove it, and then completely close the opening into the trachea with a pad of wetted lint, lightly tied round the neck with a soft bandage.

The first few breaths are often very laboured. As a rule, it is chiefly inspiration; but occasionally expiration is also difficult. The surgeon must persevere as long as it is safe to do so. A very easy way of testing the patency of the larynx is to allow the patient to fill his chest through the tracheal wound, and then to force him, if possible, to expire it through the larynx. It is a good plan also, even before the tubes can be finally removed, to make the child attempt to phonate; for this exercises the muscles, and overcomes the rigidity arising from inflammatory thickening. It will be found

useful to spray the pharynx with strong alum solution, especially when the child is trying to use the larynx, for the spray will be drawn in along with the air, and so reach the glottis.

Usually there are no great difficulties: such as there are will be considered under "Complications." The tubes having been removed, the wound may be allowed to close. A pad of wet lint is all that is required. If the granulations proliferate, let them be touched with nitrate of silver stick. Sometimes a little zinc ointment or lotion will be better.

Diet.—The late Professor Trousseau used to teach that a good appetite was one of the most hopeful signs in a child that had been tracheotomized. Unfortunately it is rare, and not a little of our after-trouble consists in persuading our patients to take nourishment. On this account, we must be on our guard against overdoing it. I have known, otherwise excellent, nurses ply their patients every half-hour, or oftener, with either milk or beef tea, or some other article of diet, that may have been ordered. This practice I consider as injudicious as it is injurious. It is impossible for the stomach to be digesting food continuously; and unless the food is digested, it only distends the stomach and gives rise to general malaise and discomfort. In children or even adults, where the depression is great, this digestive inactivity specially obtains; hence at *post-mortem* examinations it is very common to find the stomach distended with undigested food, so much as materially to interfere with the heart's action, as well as with expansion of the lung. In other cases, this ill-advised feeding leads to vomiting.

It is, I know, easier to advise what ought not to

be done, than to give any definite instructions on this point as to what should be done. The moral of what precedes is that *a little food which is digested* is of *greater value than a large quantity which is merely swallowed.*

By some it is considered necessary to order beef tea and milk quite irrespective of the likes or dislikes of the patient. Children, as a rule I think, dislike beef tea. Under those circumstances I should not advise its being continued. The same as regards milk. More solid food may be given, if it be wished for, without any danger. Indeed *soft solids are more easily swallowed than liquids.* The latter seem to find their way into the larynx, and then they give rise to coughing. Beef tea and milk may now and again be advantageously thickened with biscuit powder, or sago, or tapioca, or with chocolate. Light puddings are relished. Raw lean meat, chopped *very* fine, is an excellent way of giving animal food.

A little wine or brandy will sometimes sustain life, and put one over a period of depression and exhaustion, which would be fatal without it. This is especially the case where from any cause the vomiting is severe, and accompanied with diarrhœa. Nutritive enemata, thickened with raw starch and containing a small opiate, may be administered every few hours.

Vomiting and diarrhœa in a few cases occur and persist; they are very exhausting. I believe they sometimes depend on the action of drugs given before the operation. Their action of course tends gradually to wear off.

I will close this chapter with another caution against too frequent feeding. *Every two hours is often enough*

when the food has to be forced; and then a measured quantity should be given. If the patient ask for it oftener, then well and good. The return of the appetite is a most hopeful sign, and generally a harbinger of success.

CHAPTER V.

COMPLICATIONS.

I SHALL only include such complications as are directly due to tracheotomy. Broncho-pneumonia, therefore, will not be included. I feel that it belongs more to the domain of the physician than of the surgeon, and further I regard it as a complication following on tracheotomy rather than as one due to it. I cannot agree with those who attribute the pneumonia to the operation; for it seldom ensues on this operation when undertaken for morbid conditions other than diphtheria; whereas it (pneumonia) is constantly found *post mortem* in cases of diphtheria, which have *not* been tracheotomized.

The complications which are most commonly met with, may be arranged into two chief classes:—

1. Those which affect the wound or pharynx (extra-tracheal).
2. Those which concern the trachea itself (intra-tracheal).

Among the former, we get—

Inflammatory œdema of the neck,
Diphtheria of the wound, and
Pharyngeal obstruction.

Among the latter—

Difficulties in the final removal of the tube, depending on—

1. Mechanical causes—
 Adhesions between vocal chords.
 Growth of granulations.
 Pressure sores.
 Cicatricial narrowing.
2. On other (non-mechanical) causes.

I. Extra-tracheal Complications.

1. **Inflammatory Œdema of Neck.**—Injuries to the neck, as is well known, not infrequently give rise to inflammation of its cellular tissue; and this inflammation, on account of the anatomical structure of the parts, is often of a serious nature. The only wonder is that it does not occur after every tracheotomy, especially when the operation is undertaken for diphtheria.

My own experience would lead me nevertheless to regard it as a comparatively rare event. It seems to occur either after operations which have presented some unusual difficulty, or after operations which have not been well performed.

If, in exposing the trachea, the intermuscular planes be unduly opened and dissected, it is easy to understand how and why inflammation of the cellular tissue should be set up by pus and tracheal secretions finding their way in; and how in consequence of gravitation and the distribution of the fasciæ this inflammation may occasionally extend even into the mediastinum.

In cases of diphtheria, where the septicæmia and general prostration are at all marked, this cervical cellulitis becomes a serious complication. In illustration, I will append the details of a severe case, and the treatment which was adopted:—

J. W., ætat. 3 years, a pale, flabby child, was admitted, under the care of Dr. West, into the Hospital for Sick Children, suffering from diphtheria. In this case there was no difficulty at the operation, the trachea being rapidly and fully exposed before being incised. The child was completely relieved by the operation, and for the first few days appeared to be doing very well. But his temperature remained high. On the fourth

day after the operation he was obviously less well, and there was an amount of depression which caused us considerable anxiety. There did not appear to be any chest complication to account for this. On removing the tube, the edges of the wound were found to be gaping and œdematous, and there was a copious and offensive tracheal discharge. On the fifth day an inflammatory œdema of the anterior part of the neck supervened, and rapidly increased in extent, so that the chin, neck, and sternum presented one continuous level. The tissues were brawny, and slightly reddened. There was a trouble some cough, and at each effort the tube was dislodged from the trachea, upon which a "choking fit" immediately supervened. Owing to this swelling, our longest tube barely sufficed to reach the trachea, hence it had to be constantly held *in situ* by a nurse, but the boy was, nevertheless, nearly suffocated on several occasions. Fortunately the inflammation, having got to this stage, began to recede, and there was neither sloughing nor suppuration. We diligently applied lead lotion made with milk. One drachm of liq. plumbi was mixed with two ounces of fresh milk; this was formed into a cream, and applied with a camel's-hair brush. Internally we gave tonics. He was kept in the croup bed, and made to respire moist air containing creasote. We were not able finally to remove his tube until the twenty-sixth day of the disease, and then only after many unsuccessful previous efforts. The boy remained weak and anæmic for some time after being discharged from the hospital. (Vide Appendix, case I.)

Although cellulitis to this extent is very unusual, there is a little in most cases. As before said, the loose cellular tissue in front of the trachea is a suitable soil for its development, while the attachments of the cervical fasciæ greatly favour its extension. Had sloughing taken place in the case just recorded, it would almost certainly have proved fatal. The dangerous nature of the complication is a strong argument in favour of great care during the operation.

2. **Diphtheria of the External Wound.**—The frequency of this complication seems to depend either on the severity of the primary disease, or on the nosocomial influences to which the patient is exposed after his operation. In my own practice—at best very limited—it has only occurred twice, and on each occasion it was very slight. In one case, on removing the outer tube, I found the wound patched over with little islands of false membrane: in another case, a similar condition of the wound was found; its edges were everted, and a margin of redness surrounded them. In both cases I applied the hydrochloric acid and glycerine, and they quickly recovered without any further trouble. Attention to cleanliness and to the principles of ordinary hygiene are the obvious treatment for such cases.

French authors always refer to this complication. In 1855, Trousseau taught that "during the first four days the entire surface of the incision should be vigorously cauterized once a day: one may thus avoid a very redoubtable complication—the diphtheritic infection of the wound."

Millard, in his excellent thesis, a few years later, under the heading of "Local Treatment," stated as a "fundamental rule" that "whatever be the condition of the wound, it ought to be cauterized during the first three or four days."

Such treatment is no doubt necessary under the conditions in which it was advocated. I venture to think, however, that *the croup bed, with its supply of warm, moist, and disinfecting fresh air,* will be found still more efficacious for the local as well as for the general condition. The occurrence of such a complication—the direct effect of local inoculation—is another argument in favour

of the local treatment of the trachea and larynx advocated in the foregoing pages. It seems somewhat remarkable that Trousseau should have advocated such heroic measures to prevent the spread of the diphtheria to the external parts, and yet, as regards the internal, teach "that when once tracheotomy has been performed, we need not further occupy ourselves with the pharyngeal or the laryngeal manifestations of the diphtheria, which claimed such energetic treatment previous to the operation. They get well of themselves."

3. **Pharyngeal Obstruction.**—In a few cases, the source of the obstruction is to be found in the pharynx. It consists in inflammatory thickening and rigidity of the epiglottis, and aryteno-epiglottic folds of mucous membrane, spreading in all probability to the glottis itself. I believe this condition exists in all cases to a slight degree; for we seldom get through even a favourable tracheotomy without some troubles in connection with swallowing, which depend on the same cause. If the diphtheria has spread from the pharynx, or if it has been at all severe, such an obstruction is the more likely to occur. It can easily be appreciated by the finger. The most appropriate treatment is the spraying of alum solution into the pharynx; a saturated solution of alum may be used, and the addition of a little glycerine will make it more palatable, and help it to adhere to the diseased parts. Sometimes a little diluted iron solution will be found more serviceable. In any case, the tube should, if possible, be removed while the spray is being used; for this obliges the patient to use the larynx, which adds to the efficacy of the remedy.

In cases of tracheotomy for foreign bodies, it is well to

bear in mind that difficulties in the removal of the tube point to a continuance of the original source of obstruction, either in the glottis itself or on its pharyngeal surface. Thus, in one case which I had an opportunity of seeing, a piece of egg-shell was found adhering to the side of the thyroid cartilage close above the glottis; its presence was not detected until after death, though it might have been suspected in consequence of the persistence of the laryngeal obstruction, when attempts to remove the tube were commenced some days after the operation.

II. Intra-tracheal Complications.

Difficulties in the final Removal of the Tube.—It sometimes happens that we cannot finally remove the tube in consequence of our patient being unable to breathe for any length of time through the glottis. The difficulty is generally most obvious at night; or during the day, should the patient try to sleep. It would seem as if the ordinary muscles no longer suffice for their work, and that difficulties set in, when sleep comes on, because the extra-ordinary muscles of inspiration then sleep too.

In a certain number of cases, no mechanical obstruction exists; the phenomena seem due to purely reflex nervous derangement; in some cases, this nervous derangement is aggravated by inflammatory thickening of the chords, and of some of the muscles which control their movements. In other cases—and it is quite easy to understand these—mechanical impediments exist. I will refer to them in the following order:—1. Adhesions between the vocal chords. 2. Growth of granulations. 3. Pressure sores on the tracheal wall. 4. Cicatricial narrowing.

Adhesions.—The chink of the glottis may become, more or less completely, obstructed by a web-like growth extending between the margins of the chords. I presume that a quantity of plastic lymph is thrown out, and that adhesion takes place between the nearest opposed surfaces, just as it occurs in the chest, or in the pericardium under similar circumstances.

Such a condition may be suspected if, on trying the glottis, it is found to be completely, or nearly, closed, and if during attempts of inspiration or expiration it is found impossible to get any air to pass. The voice will be entirely suppressed. I believe that attention to the details of treatment of the larynx and glottis on which I have insisted will lessen the chance of such an occurrence. If, nevertheless, it should occur, a bougie should be passed into the glottis, and made to move in a direction from before backwards. This will effectually break down any adhesions. Subsequently, the larynx is to be sprayed with a strong solution of alum. Or a little nitrate of silver solution (gr. 5–10 ad ʒj) may be applied. Some such instrument as the one here figured will be found useful for this purpose.



FIG. 14.—An Instrument for applying Solutions to the Larynx through the opening in the Trachea.

It consists of a piece of glass tubing bent to the required shape; it is then introduced through the wound into the larynx, having been previously charged with a few drops of the silver solution. It is then gently blown out of the tube into the larynx.

Granulations.—Perhaps a more common cause of difficulty is the growth of granulations along the margins of the tracheal wound. In some patients they grow very luxuriantly. I have seen them attached by short but distinct pedicles, and arranged like a bunch of currants. If they chiefly affect the upper margin of the wound, they are very liable to interfere with the breathing when the tube is removed. In such cases expiration is often more difficult than inspiration; for the current of air forces them towards the glottis in expiration, while inspiration rather draws them away. The granulations sometimes bleed freely: the presence of blood in the expectorations is, under the circumstances, a sign of some little diagnostic value. The granulations may also extend down the trachea as far as the tube reaches. So long as the tube is *in situ*, they are kept compressed; but when the tube is removed with a view to try the glottis, and has been out of the trachea for some time, these granulations, relieved of the pressure of the tube, swell out, and little by little so obstruct the breathing that the tube has to be re-inserted. In replacing it there is generally some slight admixture of blood with the tracheal secretion, and here again do we get a suggestion of the possible nature of the obstruction. Pedunculated granulations, growing from the tracheal wall near the lower orifice of the tube, have occasionally got into the tube, and by obstructing it suddenly have proved fatal. Nitrate of silver is the best application for such cases. It may be applied in solution as directed in the last paragraph, or, better still, in the solid form. For this purpose, a bent probe is to be coated with nitrate of silver, previously melted in a teaspoon over a spirit lamp. The coated probe is then passed in through

the tracheal wound, and applied wherever the surgeon wishes.

A granular condition of the trachea can be detected by using the laryngoscopic mirror, and in cases of difficulty it is always well to try this plan. When the obstruction is situated low down, the voice is often unaffected.

Pressure Sores.—I must next refer to ulceration of the tracheal wall, which occasionally occurs. It generally commences on the anterior wall, corresponding with the lower extremity of the tube. *It is always the result of an ill-fitting tube.* Such an accident may of course happen in spite of any precautions, but it is the more likely to happen if the instruments we use are not carefully adapted to their purpose. I would again refer the reader to Fig. 5, page 31, and to what has there been said regarding the shape of the tubes.

In one case at least the tube, after ulcerating through the trachea, at last found its way into the innominate vein, causing immediate death. As to the treatment of such cases, little more need be said than that if the cause be removed, the effects will probably soon pass off. If the trachea shows any evidence of being easily irritated, the sooner the tube is removed the better; if the tube cannot be entirely removed, reduce its length by degrees, and keep it out during as long periods as the patient can get on without it.

Cicatricial narrowing.—Narrowing of the trachea is occasionally met with. Its occurrence is possible after tracheotomy, where there has been much sloughing or destructive disease, either in the trachea or around the incision into it. I have seen one case where stridulous breathing, years after the operation, probably indicates this pathological condition. The treatment of such cases,

to be of any avail, must commence early; even then it is not very satisfactory. It should consist in the passing of graduated bougies, hollow, so that respiration can be carried on during the process of dilatation. Better still will be the adoption of such measures as will prevent its occurrence. These have been already referred to in the preceding paragraphs.

II. CASES WITHOUT OBVIOUS MECHANICAL OBSTRUCTION.—I have mentioned the most common varieties of the mechanical obstacles which prevent the final removal of the tube, and I will next refer to cases where, though no such impediments exist, great difficulties nevertheless present themselves. It will perhaps be best to give the details of a very typical case, and then add some further remarks afterwards.

M. T., ætat. 2 years, a very delicate child, was tracheotomized on account of severe diphtheria. Other members of the family had suffered, though in a varying and less severe degree. The child had previously been treated with emetics. The operation afforded immense relief; flakes of membrane were spontaneously coughed out, as well as wisped out with a feather. On the day after the operation he had a troublesome hacking cough, which much exhausted him. He was accordingly chloroformed, the tube taken out, and the larynx and trachea were again carefully cleaned out, after which the tube was again inserted. Benzoin inhalations were then ordered, and he was much relieved for a time. The cough, however, returned; so a few whiffs of chloroform were given through the tube, shortly after which it passed off. We tried the larynx on the fourth day, and found considerable breathing power.

Here it must be stated that the child was highly nervous, put himself into a passion, and cried very much whenever he saw me. He never got the better of this fear, although I had him under care for five months. I venture to mention

this fact, because I think it helps to explain some of the difficulties of the case.

On the sixth day after the operation, with the tracheal wound closed, *he spoke a few words quite distinctly.*

On the twelfth day little or no progress had been made.

On the seventeenth day he could *inspire a little and expire freely* when the tube was out.

On the twenty-fifth day the tube was removed, and kept out for fifty minutes, without producing any great amount of distress, after which it had to be replaced.

On the twenty-seventh day, *and without any obvious change in the boy's condition*, he could not breathe at all through the larynx, and the tube, which had been removed for the trial, had to be replaced very hurriedly.

The boy's general health had been improving daily, and he was taken out when the weather permitted.

We continued to make these trials, with a varying amount of success. Several differently-shaped tubes were made for him; some with, others without, a window, and the length as well as the curve were altered, so as to avoid intratracheal erosions.

When two months had elapsed, the external wound having cicatrised, except a narrow channel for the tube, a new complication set in. On removing the tube, this channel into the trachea (which was lined with young cicatricial tissue) gradually closed, so that it was difficult to re-introduce the tube when the state of the breathing rendered it necessary. I therefore used a plug, made of gutta-percha, similar to the one here figured.



FIG. 15.—A Silver or Gutta-percha Plug.

This plug just reached into the trachea, and so prevented closure of the opening; but it was not long enough to interfere in any way with the respiration. We also had recourse to a short tube with a large window in its convexity;

this was corked at its external orifice, and the boy was thus made to breathe through his glottis. Thus we continued for another month, *making way but very slowly indeed.* Although he got on well enough in the daytime, he could not sleep a wink at night without the use of his tube.

Exactly three months after the operation he contracted scarlet fever. Although there was no dangerous faucial complication, there was sufficient inflammation to undo all that we had gained during our attempts to remove the tube; in fact we found it obligatory to desist from these attempts. At this time we had the advantage of a consultation with the late Dr. Murchison. When the fever was over, we recommenced our attempts to get rid of the tube, working exactly on the same plan; and, as before, with varying success. I may sum up by saying that the boy could breathe through his glottis with comparative ease (and could talk with considerable distinctness) while awake, but not at all when he fell asleep. In the fourth week after scarlet fever, albuminuria supervened, and he became very low and ill. Somewhat later on he had a severe cough, and his temperature was high—on one occasion 105° F. Dr. Ord now gave us the benefit of his assistance. We feared that general tuberculosis might be setting in. However, under the influence of tepid bathing and the inhalation of sulphur vapour, he began to improve. I then advised his removal to Margate, his father going with him and taking charge of him. He remained at Margate about a month, and he returned home greatly benefited in every way. His temperature had become normal; all traces of albumen disappeared from the urine.

We again recommenced our attempts to remove the tube, adopting the tactics already described. Finally we succeeded on the 175th day after the operation. The first night he had to sleep without the tube was a very anxious time for us; for the boy seemed about to choke on several occasions. *Fortunately we persevered.* When his difficulties got beyond a certain point he woke up, and then his breathing became comparatively easy. These nocturnal difficulties came on again and again, and it was some weeks before he could sleep at all

soundly. At the present time the boy is vigorous and strong, and has quite outgrown all his former troubles. I ought to have stated that we tried galvanism to the muscles of the neck, but without any obvious good. (*Vide* Appendix, case xvi.)

In this case, there can be but little doubt that the earlier difficulties in removing the tube depended largely on local inflammatory changes, and as these gradually subsided, some progress was made. Then on the supervention of the scarlet fever, further inflammation of the throat came on, and threw us back again. Some weeks had now elapsed since the operation, and probably the effects of disuse of the laryngeal muscles were added to the already existing difficulties of the case. Meanwhile, further complications showed themselves, and the general health of the patient began to fail. We now found it impossible to continue our trials; hence the child was sent to the seaside for a month, during which time no attempt to remove the tube was made. It was corked up during the day, so that the boy used the larynx both for breathing and speaking, being allowed to breathe through the tube at night. On his return home, strong and well, we at once re-attempted the permanent removal of the tube, and after some unsuccessful trials we succeeded.

I think Mr. Thomas Smith, in a special paper on the subject,* ably sums up what we at present know about such cases in the following words :—

"The mental agitation caused by the dread of impending suffocation, which the removal of the canula produced, was sufficient to derange the normal action of the laryngeal muscles, so as to prevent the regular dilatation of the rima glottidis at each inspiratory act.

* 'Medico-Chirurgical Transactions,' vol. xlviii. p. 232.

"It might also be that the influence of the will was necessary to regulate and secure the due action of these muscles, the perfection of whose movements had been impaired; and that on this account inspiration through the larynx during sleep was impossible."

The various cases at present recorded do not permit of any analysis which would be useful to the readers of this book. This much, however, is taught; that we must commence our attempts to remove the tube early; and our efforts must be persevered in, even though at first they prove but partially successful.

For, in the difficult cases—upon whatever cause the difficulty depends—procrastination or delay will but increase it. If disuse of the vocal chords be the cause, the obvious remedy is the re-establishment of the normal function at the earliest possible moment; if it depend upon granulations in the larynx or trachea, the longer they remain the more they grow; the firmer and more organized they become, and the more difficult will they be to deal with; while if the trouble be a mnetal one, our efforts must be redoubled in order to prevent this perverted function from taking on the form and the force of a confirmed habit.

CONCLUDING SUMMARY.

The local condition in diphtheria precedes the general ; the latter depends on the absorption of the septic products of the local condition.

The disease spreads by the contagion of its own products.

Spread of the disease must be combated by the complete destruction and removal of the products of the local lesion.

Death very generally occurs from the extension of the disease into the lungs.

The performance of tracheotomy must not suspend or in any way interfere with the treatment of the disease, one object of the operation being to facilitate treatment and to guard against death from mechanical causes while this treatment is being carried out.

The operation of tracheotomy is only indicated where there is evidence of mechanical obstruction in the larynx.

Retraction of the soft parts of the anterior chest-wall, together with the more or less complete suppression of voice, are the indications *par excellence* for its performance.

To be of service, the operation must be performed early, and before general diphtheritic infection of the system or secondary lung complication render it practically useless.

APPENDIX OF CASES

In which the after-treatment advocated in the foregoing pages was carried out, more or less, according to the individual requirements of the cases, with the results.

SYNOPSIS OF RESULTS.

Where Operated.	Totals.	Recoveries.	Fatal Cases.	Remarks.
Hospital for Sick Children (Great Ormond Street)	15	9	6	Mr. Marsh operated in two of the nine successful cases. Seven of the nine successful and all six unsuccessful cases were my own operations.
Private cases	2	1	1	My own operations.
East London Hospital for Children (Shadwell, E.)	4	2	2	One of the two unsuccessful operations was my own. The two successful operations and one unsuccessful case were operated on by Mr. Hayward, resident medical officer.
Totals	21	12	9	

CASE I.

James W., ætat. 3 years, was admitted on February 20, 1873, into the Hospital for Sick Children, under the care of Dr. West.

Condition on Admission.—The pharynx was congested; tonsils very large, and coated with a thick white deposit, which could *not* be peeled off. The uvula, although in contact with the tonsils (on account of their large size), was not affected, as far as could be seen. There was a croupy cough; breathing was laboured, and especially so after any exertion or crying. Air did not seem to be entering the lungs at all freely. There was no albumen in the urine.

The boy gradually got worse. Two days after admission I performed tracheotomy, Mr. Marsh assisting me, Dr. West and Mr. Haward also being present. The bed was surrounded with curtains, and Dr. Gee's steam apparatus was employed. A few drops of creasote were from time to time added to the water. Four days after the operation the tracheal wound began to inflame, and inflammatory œdema spread to the neck all round; there was great difficulty in keeping the canula in the trachea owing to its depth from the surface of the inflamed skin. The trachea was constantly feathered out, and any accumulation of mucus, &c., cleared away. The tube was not finally removed until March 20, being twenty-six days after the operation. He was discharged April 6.

The case is also referred to in the chapter on Complications, *vide* page 54.

CASE II. (fatal).

Bridget E., ætat. 1 year 8 months, admitted, under Dr. Dickinson, June 2, 1873. Had been ill one week. On admission respirations were laboured and frequent—44 per minute. There was great recession of anterior chest-wall. Lips livid. An examination of her throat showed the tonsils large and prominent, and coated with white membrane. Antimonial treatment was at once commenced and pushed; but it gave her no relief. She was almost moribund when the operation was performed, but it afforded the most complete relief at first. Steam, with a few drops of creasote, was ordered. Before insertion of the tube, the trachea was well cleared out with a feather. Breathing again became laboured after about thirty-six hours, although the trachea had been carefully and constantly cleared out, and was free from any obstruction. The child died on the third day. My notes particularly refer to the fact that there was no secretion from the trachea, and no cough, and that even the introduction of a long feather failed to induce cough. The *post-mortem* showed the pharynx to be patched over with membrane, *and that the larynx, as low as the entrance of the tube, was choked up with membrane.* There was no membrane *below* the tube.

It was this case which particularly decided me in future cases to clear out the larynx with a feather, or in some other way, in the same manner as the trachea. And, in the light of the *post-mortem* examination, I could not but feel that the presence of such membrane must be dangerous, as a source of infection, as well as a mechanical impediment to respiration.

CASE III. (fatal).

Rosetta K., ætat. 3 years, was admitted, under Dr. Dickinson, on February 25, 1874. Until the day before her admission she had been apparently quite well. Her breathing had suddenly become laboured and audible at 10 P.M. the night before her admission. There was no known cause to account for the disease.

She was placed in the covered bed, and steam, with a little creasote, was turned on. Four quarter-grain doses of antimony were administered, after which she vomited. There was then some amelioration of symptoms — she slept at intervals. Suddenly, during the following night, she had an attack of intense dyspnœa; she appeared to be dead when I got to her. I nevertheless performed tracheotomy, and after practising artificial respiration for some little time the child revived. As soon as the trachea was opened, and respiration recommenced, a piece of tough, well-formed membrane was coughed out. I imagined that this membrane had become partially loosened, and that in expiration it had flapped up against the glottis and prevented the passage of air from the lungs. She experienced most perfect relief from the operation. On the following day it was noted that the trachea seemed very tolerant of interference, and that there was very little bronchial secretion. Breathing again became laboured. I now cleaned out the trachea with a pair of fine, long, curved forceps and a sponge. This gave relief, but dyspnœa again came on. I next passed a No. 12 elastic catheter down the trachea, and sucked out a quantity of membrane and thick tenacious mucus. This, too, was followed by relief. The aspiration had to be repeated many times, and soda solution was instilled in the hope of facilitating the

expulsion of this matter. Each aspiration afforded some relief, but the child died forty-eight hours after the operation.

The absence of bronchial secretion was again a prominent feature of this case. All our attempts to promote it failed. Steam, creasote, expectorants, and local applications were all prescribed, without any permanent benefit.

CASE IV.

William S., ætat. 2½ years, admitted, under Dr. West, May 23, 1874, with marked stridor and a "whisper" voice. Recession of lateral parts of chest, more marked on the right than on the left side. The stridor was only marked during inspiration.

On the third day after admission I tracheotomized the child, Mr. Marsh helping me, Dr. Gee being present. Immediate relief followed. On the following evening, his breathing being again embarrassed, I gave him a benzoin inhalation (using Dr. Lee's steam draught inhaler), after which, with the aid of a feather, I got up a quantity of membranous exudation. Some œdema and redness were also noticeable about the tracheal wound, and spreading from it. Early on the following morning I was called up and found the child covered with a scarlet fever rash. He was at once isolated. He passed through the fever fairly well; there was never any albumen in his urine. We experienced some difficulty in finally removing the tube, and many attempts were made before we succeeded, on the thirty-fourth day after the operation. He was discharged "cured" on July 10.

CASE V.

Albert W., ætat. 2¼ years, admitted August 22, under Dr. Gee, with urgent dyspnœa; cold and pale. He was a small, underfed, backward child, with open anterior fontanelle. Inspiration was especially laboured, and there was stridor with expiration.

I operated about four hours after his admission. Steam was turned into his bed as usual. The mode of treatment advocated

in the body of the book was adopted. The canula was finally removed on the ninth day, and the child was discharged on the twenty-fifth day after admission.

CASE VI.

Lizzie S., ætat. 6 years, admitted October 11, 1874, under Dr. Dickinson. There was a history of other children having been ill with "sore throats," and one had had "fœtid discharge" from the nose. The child's mother also was attacked with "sore throat," and when examined she was found to have great congestion and œdema about the pharynx and tonsils, together with patches of exudation about the gums; also cervico-carotid glands swollen and tender.

This little girl was tracheotomized a few hours after her admission, having been ill altogether eleven days. The tonsils were patched over with membrane—pharynx generally red and tumefied. Breathing was very laboured. Voice not quite, but almost, gone. The urine, before the operation, became almost solid with albumen when boiled. That which was passed six hours after the operation contained very little, and during convalescence the greatest amount on any day never exceeded one-fifth. The treatment consisted in the local application of hydrochloric acid and glycerine to the gums and pharynx. After the operation the trachea was wisped out with a feather and the soda solution. Steam was employed as usual. The tube was finally removed on the twelfth day, and she was discharged from the hospital on the twenty-eighth day after admission.

CASE VII.

Ellen S., ætat. 8 years, admitted into the Hospital for Sick Children, under Dr. Dickinson, on November 2, 1874. She had been ill one week; she walked to the hospital, a distance of three quarters of a mile, on the day of her admission.

She was treated at first with antimony, and after vomiting she was greatly relieved; this relief, however, proved to be only temporary. Tracheotomy had to be performed at 3 a.m.

on the third day after admission. There was no albumen in the urine. Considerable quantities of very thick membrane were expelled at different times. Tube was finally removed on the eleventh day. She was discharged on December 3rd, thirty-one days after her admission.

I examined this girl's throat with the laryngoscope; the vocal chords could be seen to be bordered with a white edge of false membrane. Her voice was scarcely audible.

CASE VIII. (fatal).

John W., ætat. $2\frac{3}{4}$ years, admitted into the Hospital for Sick Children, under Dr. Dickinson, November 19, 1874. The onset of the disease was sudden. Antimony was prescribed, and great amelioration followed. There was a relapse, and capillary bronchitis supervened. Emetics (sulphate of zinc, gr. x.; ipecacuanha powder, gr. x.; in water $\frac{1}{2}$ ʒ) were ordered, which did not, however, act. The respirations were eighty-four per minute; coma now came on.

I was requested to perform tracheotomy, which I accordingly did. The child never moved during the operation; there was no sensible relief after it. Some blood-stained mucus was aspirated by means of the catheter from the bronchi, and the trachea was wisped out with a feather, but no reflex cough or irritation was produced. When any attempt to give food was made it came out through the larynx. Turpentine stupes were ordered, but without any effect.

I then manufactured some oxygen gas, and allowed the child to breathe air charged with oxygen, but this did not produce any very appreciable effect. The child died ten hours after the operation, without having become conscious.

CASE IX. (fatal).

Emma Y., ætat. 2 years, admitted into the Hospital for Sick Children, under Dr. Gee, January 23, 1875. She had been ill for six days, the first onset being rather sudden. On examination the mucous membrane was found of a livid colour and swollen, but no membrane could be seen.

Tracheotomy was performed two or three hours after her admission, as the child had become very much worse. Artificial respiration had to be kept up for some time after the trachea was opened. No membrane was got up, although I aspirated the trachea and bronchi with a large-sized elastic catheter. No membrane was ever got up in this case. At the operation the narrowness of the cricoid orifice had been remarked. This seemed owing to *tumefaction of the lining membrane.* There was a discharge of thick muco-purulent matter. The tracheal wound began to slough. When the silver tube was removed for cleaning, its lower extremity was found to be blackened (a circumstance which always suggests to me an unhealthy condition of trachea). Mercurial treatment was ordered by Dr. Gee, and continued for three days, but without any marked improvement. The child's general condition became worse and worse, and the wound more unhealthy. She died on the nineteenth day after the operation of septicæmia and exhaustion.

CASE X.

Merrimar H., ætat. $6\frac{3}{4}$ years, was admitted, under Dr. Dickinson, on January 30, 1875, with typhoid fever. She was in the third week of the disease. Some eight or ten days after her admission she was noticed to have a "croupy" cough. This went on for a week, when her breathing became so bad that tracheotomy became necessary, and had to be done one morning at seven o'clock. There was no large amount of albumen in the urine. The tube was finally removed on the ninth day. Steam, with tincture of benzoin, was used as usual; the trachea was kept free with a feather and soda solution. The child did very well in spite of her typhoid fever, and she was discharged from the hospital on the twenty-fifth day after the operation.

CASE XI. (fatal).

Ada R., ætat. $3\frac{1}{4}$ years, admitted, under Mr. Thomas Smith, on March 4, 1875, with a laryngeal obstruction, following on a scald of the pharynx and glottis. Five days before admission

she had drunk boiling water out of a kettle, which was standing on the hob. The immediate symptoms were not marked; so little marked, indeed, that a doctor was not called in until thirty-six hours after the accident. Her breathing did not become difficult until the third day, nor urgent until the sixth day. An ice-bag was applied to the neck for two or three hours without relief.

I tracheotomized the child, adopting afterwards my usual treatment as already detailed. She died about forty-eight hours after the operation. Tubular casts of the smaller bronchi were found in the lungs after death. This case and the preceding one are given in full in a paper which I contributed to the Clinical Society's 'Transactions,' vol. viii., 1875.

CASE XII.

James C., ætat. 4 years, admitted, under Dr. Dickinson, on April 1, 1875. The boy had been ill four days.

I operated shortly after his admission, the symptoms being urgent. Considerable quantities of gelatinous-like membrane were got up, also some thick muco-purulent discharge. A copious bronchial secretion began about two hours after the operation. The steam apparatus was at work, and soda solution was from time to time sprayed into the throat. The tube was removed on the fifth day; he was up and dressed on the seventh day, and discharged from the hospital on the twenty-first day, quite recovered.

CASE XIII. (fatal).

Emily B., ætat. 3½ years, was admitted into the Hospital for Sick Children, under Dr. Cheadle, on May 10, 1875. The symptoms began to be manifest three or four days before admission. Both tonsils were then eroded, and on each there were patches of dirty white membrane. There was a rim of membrane also along the free margin of the epiglottis. A hot bath afforded no relief, and vin. ipecac. failed to cause vomiting.

I operated about one hour after her admission. Great relief followed. The tracheal wound began to inflame on the following

day, and erysipelas and œdema developed. Her urine contained one-third albumen. She died of blood poisoning on the third day.

CASE XIV.

Augustus K., ætat. 5 years, admitted, under Dr. West, April 8, 1873. He had been ill about eleven days, and was much exhausted when admitted; there was great recession of lower intercostal spaces and of epigastrium. No membrane was visible in the pharynx. Emetics failed to relieve him.

After consultation, Mr. Howard Marsh, at Dr. West's request, performed tracheotomy. There was a trace of albumen in the urine. The tube was removed finally on the eighteenth day. He was discharged from the hospital on May 14th quite well.

CASE XV.

William W., ætat. 3¼ years, admitted, under Dr. Dickinson, on May 13, 1875. There was a history rather suggesting congenital syphilis. Three months before his admission he had some kind of a laryngeal attack, for which he was treated in a hospital. One month previously he had difficulty in swallowing, and had also a croupy cough, and his "breathing was loud." When admitted breathing was very laboured. He seemed to get worse up to eight o'clock in the evening, when he was seen by Dr. Dickinson and Mr Marsh; it was decided to tracheotomize him.

Mr. Marsh performed the operation. He was immensely relieved, and at once. One small piece of membrane was coughed up at the operation, and many more bits during the next few days. He did very well indeed. Our attempts to remove his canula, however, all failed. Mr. Marsh has the boy still under observation; he is wearing a flexible tube.

CASE XVI.

In consultation with Meredith Townsend, Esq., Dr. D. R. Pearson, and Mr. William Brend, all of Kensington, M. T., ætat. 2¼ years (son of the first named gentleman), came under

my observation on April 13, 1875. He was a delicate little boy, and was suffering from diphtheria severely, the general symptoms of which were as well marked as the local ones.

He was completely relieved by the operation. He nearly died of asthenia on the twelfth day. Attempts to remove the tube were commenced on the fourteenth day after the operation, but great difficulties were experienced. After an attack of scarlet fever and scarlatinal nephritis (among other complications), during which time he continued to wear his tube, he quite recovered.

The details of this case have already been given (*vide* page 62).

CASE XVII. (fatal).

X. X., ætat. 14 years, in consultation with Mr. Brend and Dr. Dudfield, of Kensington. An insidious attack. The girl was tracheotomized on April 10, 1877. A large quantity of very thick membrane was expelled. She died of general and intense blood poisoning. There was no autopsy.

CASE XVIII. (fatal).

Mary H., ætat. 2½ years, was admitted into the East London Children's Hospital, under my own care, on September 17, 1878, on account of urgent dyspnœa. She had only been ill two days. There was no known source of infection.

Tracheotomy had to be performed at once, which I accordingly did. The relief was immediate and complete. Large shreds of membrane were got out of the trachea at the operation and also during the next two days. The child's dyspnœa returned, and we failed to relieve it. She died on the second day after the operation. At the *post-mortem* examination a large shred of membrane was found on the posterior surface of the trachea; membrane was also found in the larynx.

I particularly mention this fact, for I think it tends rather to support the dictum at the close of the Preface to this book. I also think that the fatal issue may possibly have not been

wholly disconnected with the circumstance of my not having cleared away *this infective material.* Tubular casts were found in the smaller bronchi.

CASE XIX.

Elizabeth C., ætat. 4 years, was admitted into the East London Children's Hospital, under my colleague, Dr. H. Donkin, September 25, 1878. Her throat first became bad four days before admission,—that is, she was hoarse. On admission, patches of membrane were seen on the fauces. Her breathing was very laboured.

Tracheotomy was at once performed by Mr. Hayward, resident medical officer. The relief was complete. For a day or two there was a little inflammatory œdema about the neck; beyond this, there was no trouble at all. Membrane was got out at the time of the operation and during the next few days. The tube was finally removed on the tenth day. She was discharged on December 2, 1878, quite well.

CASE XX.

Theodora R., ætat. $2\frac{1}{4}$ years, was admitted, under my colleague, Dr. Eustace Smith, on September 25, 1878. Her illness commenced seven days before admission. She was sent into the hospital by a medical man with a view to tracheotomy, which had to be performed at once.

This was done by Mr. Hayward, resident medical officer. Relief was complete. A large piece of membrane was got up, which proved to be a cast of the trachea. Pieces of membrane continued to be coughed up for thirteen days. The tracheal wound assumed an unhealthy appearance, and it was coated with a filmy deposit for two or three days. The tube was finally removed on the fifteenth day. Child was discharged on December 1, 1878.

CASE XXI. (fatal).

Mary R., ætat. 9 months, admitted under my colleague, Dr. Donkin, on September 30, 1878. She had had cough and

wheezing for three weeks, but had been lively until day of admission. Mr. Hayward, resident medical officer, performed tracheotomy. Small pieces of membrane were extracted from the trachea before the insertion of tube. The operation afforded marked relief. The child died quite suddenly on the following day. The tube was clear.

At the *post-mortem* examination, the larynx was found to contain patches of membrane; no membrane in the trachea, except at the bifurcation. Small patches were also found in the smaller bronchi.

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